Rw. P. Marcus O. F. M.

$15.00
DLR# 159
INV# AY 8

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Cincinnati, O., _____, 192____

$15.00
DLR# 159
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Building-In the Radio Set

By EDWIN M. LOVE

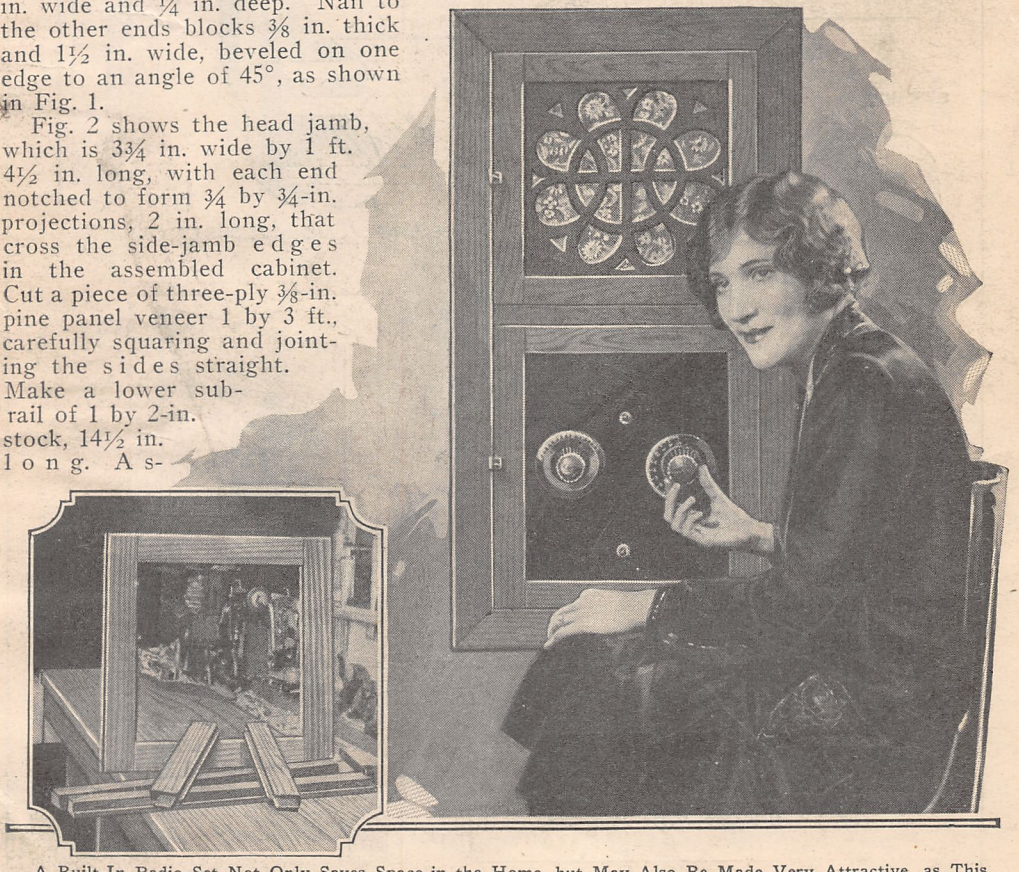
LIKE all built-in furniture, the built-in radio cabinet illustrated saves floor room by utilizing waste space in a wall, and can be finished to match the trim of the room in which it is installed. The B and C-batteries, being slung below the cabinet behind the plaster, are properly hidden without making the case unduly large. The cabinet can be adapted to a set of almost any description, up to four or five tubes.

It consists of a simple three-sided box with a back, a pair of false side casings, and the casings mitered around the front, to which the grill door over the loud speaker and the radio-panel door, are hinged.

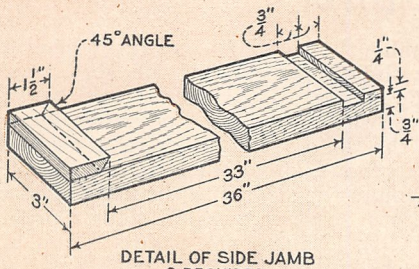
The two side jambs are of 1 by 4-in. stock, sized to 3 in. in width, with the edges beveled slightly toward the back, insuring close joints with adjacent members. Cut them 3 ft. long, and ¾ in. from one end, on the face side, work a dado, ¾ in. wide and ¼ in. deep. Nail to the other ends blocks ⅜ in. thick and 1½ in. wide, beveled on one edge to an angle of 45°, as shown in Fig. 1.

Fig. 2 shows the head jamb, which is 3¾ in. wide by 1 ft. 4½ in. long, with each end notched to form ¾ by ¾-in. projections, 2 in. long, that cross the side-jamb edges in the assembled cabinet. Cut a piece of three-ply ⅜-in. pine panel veneer 1 by 3 ft., carefully squaring and jointing the sides straight. Make a lower subrail of 1 by 2-in. stock, 14½ in. long. Assemble the side jambs with the head jamb by sliding the ends of the head into the side dados. If careful work has been done, the joint should be snug; however, if the dado is loose, drive a chisel into the groove, above the head jamb, and nail through the sides into the head-jamb ends before removing. The sides should be exactly 12 in. apart, inside. Now mark the subrail by the head jamb and nail in place across the lower ends of the sides, 2 ft. 9 in. below the head jamb. Carefully square the box and tack a diagonal strip from corner to corner to hold it until the back is nailed on.

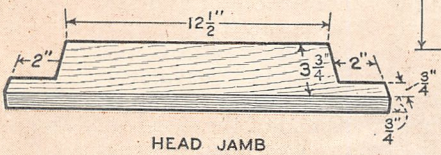
In nailing on the back, use shingle nails driven every 4 in. at varying angles, starting at one end of the side jambs and working toward the other, so that, by moving the free ends this way or that, any crookedness can be straightened by alining with the true edges of the back. Make the subcasings of 1-in. stock, sized to 2 in.



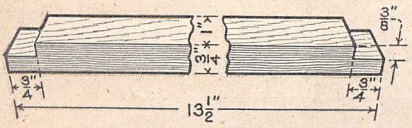
A Built-In Radio Set Not Only Saves Space in the Home, but May Also Be Made Very Attractive, as This Illustration Shows; Left, Door Frame, Stiles and Rails



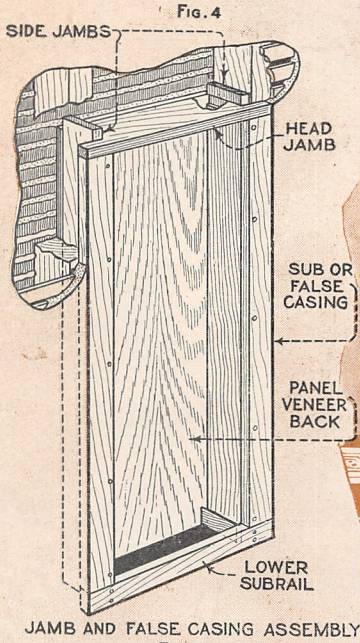
DETAIL OF SIDE JAMB
2 REQUIRED
FIG. 1



HEAD JAMB
FIG. 2



CASING MUNTIN
FIG. 4



JAMB AND FALSE CASING ASSEMBLY
FIG. 3

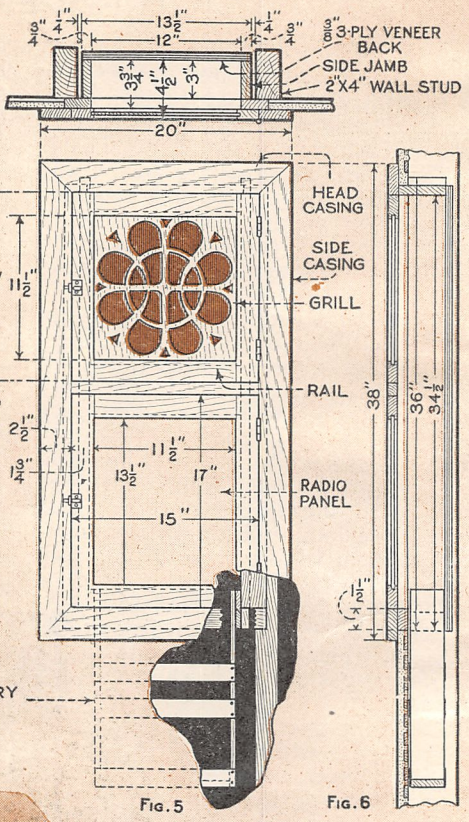
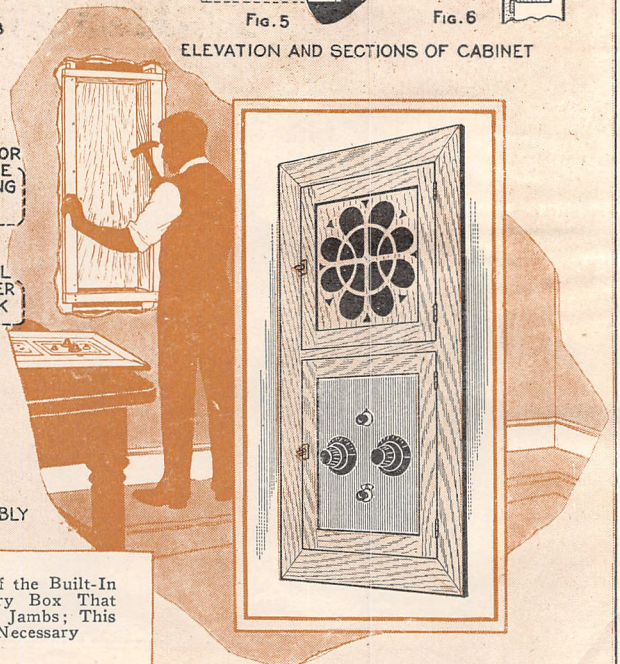


FIG. 5 FIG. 6

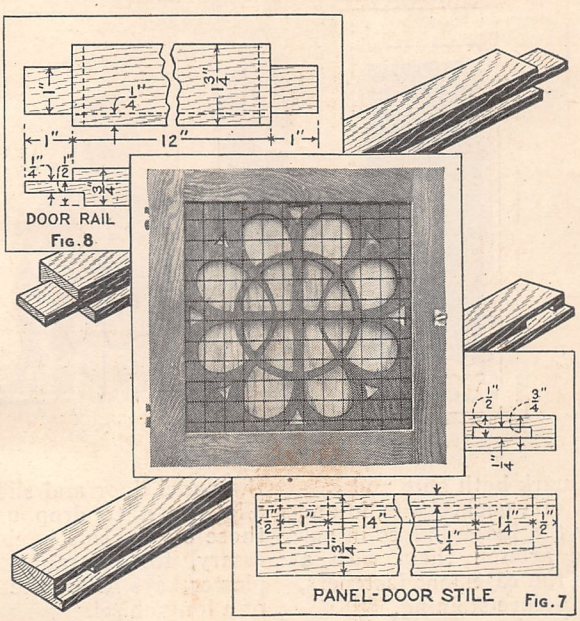
ELEVATION AND SECTIONS OF CABINET



Various Details of Construction of the Built-In Radio Cabinet; Note the Battery Box That Hangs from the Ends of the Side Jambs; This Is Easily Removed When Necessary

in width, surfaced and jointed straight. Cut to length, to force tightly between the projecting horns of the head jamb and the lower subrail, and nail to the jambs flush with the inside faces. Nail into the ends from the head jamb and subrail, and surface down all projecting members until the joints are flush. (See Fig. 3.)

Make a casing muntin of 1-in. stock, 1 in. wide and 13½ in. long, as in Fig. 4. Rabbet both ends, ⅜ in. deep and ¾ in. long, on the face side, and nail it across the false casings, as in Fig. 5, 15 in. below the head jamb. Flush with the false-casing jambs, saw off the head jamb and subrail horns. Gauge a line on each false jamb 1½ in. from the inside edge, by which to guide the side casings. The head and lower casings are flush respectively with the head jamb and subrail. Make the casings of 1-in. stock, 2½ in. wide, rounding one corner. (See Fig. 6.) The side casings are mortised to fit over the tenons of the muntin, and the corners are mitered. Tack these in place to make sure of the fit of the joints, and then remove.



The rails and stiles of the two doors are all ¾ in. thick and 1¾ in. wide. Cut the stiles 1 in. longer than net measurements, and mortise the edges ¾ in. wide, 1 in. long and 1¼ in. deep, the distance between top and bottom mortises being 12 in. on the grill door and 14 in. on the panel door. Then rabbet the same edges ½ in. wide and ¼ in. deep, as in Fig. 7.

Make the rails 14 in. long, with a tenon, ¼ in. thick and 1 in. wide, worked on each end after being rabbeted. Because the face side must fit between the shoulders on the stiles, it must be cut back ¼ in. on each end beyond the back. (See Fig. 8.) Rip the sides, rip to width, and then crosscut the sides and the edge. Fig. 9 illustrates the appearance of the assembly. Apply glue to both mortises and tenons, and clamp firmly together, protecting the edges of the stiles with blocks under the clamp jaws.

While drying, make the loud-speaker grill. Cut a piece of panel veneer, 12 in. square, and trace on it a pattern prepared as follows: Lay out a 12-in. square with lines 1 in. apart as in the photo below Fig. 8, and locate the design intersections as they appear in the photograph. With an irregular curve draw outline through these points. Then blacken the back of the pattern and trace on the stock. Carefully made, a pattern of one-fourth of the design can be used for the entire tracing. Pierce each space with a ¼-in. hole, and cut out with a coping saw. Even the inside spaces can be reached with an ordinary frame, if it is slipped through the outer spaces. Smooth the edges by draw-filing, that is, by moving the wood rasp at right angles to its length. Lightly sandpaper any ragged corners. Plane the frame joints flush, giving a diagonal cut with the grain to avoid chipping the surface, and smooth thoroughly. Tack the grill into the rabbet with ½-in. brads.

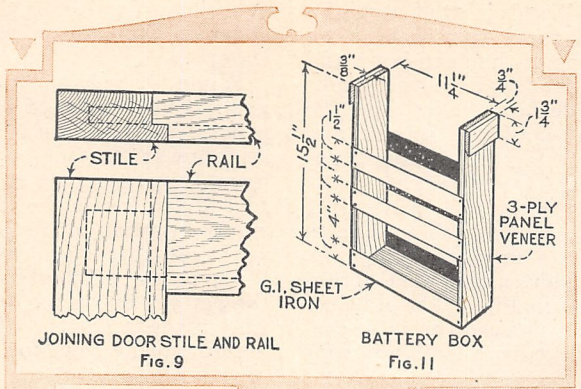
To set the cabinet in the wall, choose the place by sounding for studs with a hammer, lightly tapped on the plaster, and cut out full width between the studs and 3 ft. 1 in. long, having leveled for top and bottom. Chop away the plaster along lines plumbed 1 in. from the opening sides of the studs, and chisel out the laths. Preferably, the cabinet top, inside, should line with the tops of the doors and windows; but if this seems too high, drop the case lower. Slide it carefully in, and if projecting "keys" on the other side interfere, break them off. If the cabinet places well, lay aside and bore down through the wall plate for the lead-in; or, if an outside wall is used, simply install the cabinet and bring the lead in, and ground

through the back. Nail up the cabinet through the false casings, and nail the casings into place, after which the doors are hung. Use 1 by 1¼-in. loose-pin brass-plated hinges, placed 2 in. from the top and 2½ in. above the bottom of each door, after having fitted the latter with less than 1/16-in. clearance all around. A simple way to locate the hinges is to block the door in place, measure the position of the top of the upper hinge and the bottom of the lower hinge, and mark both stile and casing with the point of a pocketknife, in one thrust. Then lay the hinge halves in position and scribe around them with a knife. Mortise in the casement fasteners, but remove again before staining.

When the finishing is done, remove the grill door and cover the back with silk of the desired color, or with fine-mesh brass screen. Make a flat molding, ⅛ by ⅜ in., and miter it around the rabbet behind the grill. Lay the silk smoothly over the back and place one piece of mold by driving a ½-in. brad through the center. Then stretch the silk toward both ends, nailing the mold solidly. Repeat with the mold at the opposite side, this time drawing the silk tight between the two pieces as well as stretching it lengthwise. Nail in the other two pieces, again stretching the cloth, and with the point of a knife against the slightly projecting edge of the mold, trim away the loose edges. Carefully done, this results in an extremely neat job. For the battery, build the crate detailed in Fig. 11, of ⅜-in. stock, with side straps of galvanized iron, 1½ in. wide. Place two 45-volt batteries inside, one above the other, and blocked apart, bringing the lead wires up inside, and place the single C-battery. To install, open the panel door and slide the crate inside, allowing it to drop until its cleats grip those on the side jambs. It may be necessary, for clearance, to break off the plaster keys below the cabinet by the use of a long chisel.

It is best to set the storage battery in the basement, bringing the A-battery leads through holes bored in the lower header. Mount the speaker on the upper jamb of the cabinet, by means of a small iron plate bolted to it and screwed to the jamb.

Use flexible leads from the battery, speaker, aerial and ground to the set, and cut them only as long as it is necessary in order to permit the door to open fully, as any excess of wire will naturally be in the way when the cabinet is to be closed.



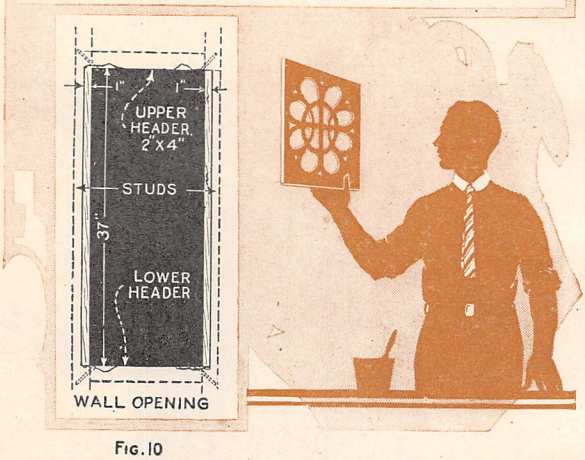


FIG. 10

MATERIAL LIST

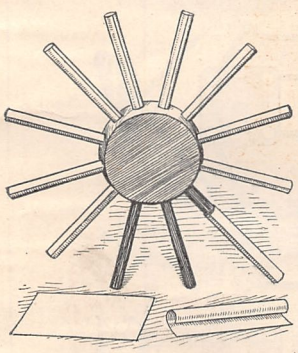
1 piece, 1 by 4 in. by 6 ft., pine, S4S, sanded.
1 piece, 1 by 3 in. by 12 ft., pine, S4S, sanded.
2 pieces, 1 by 2 in. by 6 ft., pine, S4S, sanded.
2 pieces, ¾ by 1¾ in. net by 6 ft., pine, S4S, sanded.
1 piece, ⅜ by 4 in. by 4 ft., pine, S4S, sanded.
1 piece, ⅜ by 16 in. by 4 ft., 3-ply panel veneer.
1 pair 1 by 1¼-in. loose-pin butts.
2 small casement fasteners.
1 piece galvanized iron, 9 by 12 in.

Valve Spring Makes Good Catwhisker

The small spring at the end of a tire-valve stem makes a good catwhisker. This spring can be removed by pulling off the small cap at the end of the stem with a pair of pliers. It is a simple matter to mount it on the detector stand and solder it in place. This spring is stronger than the usual catwhisker, will keep its shape and, therefore, hold a good contact.—James Hare, Norman, Okla.

Paper Sleeves for Spiderweb Coil Forms

Paper sleeves around the spokes of the spiderweb coil forms make it easier to remove the finished coil. This popular type of self-supporting coil is wound on a wooden form of the type shown in the illustration, and when the pegs are pulled out to release the coil, they often stick, owing to the tightly wound wire, and the coil is damaged. This can be overcome by cutting small pieces of light paper, 1 in. wide and the same length as the pegs, wrapping one around each peg and gluing the edge. When the coil is removed, the paper sleeves come with it and can easily be pulled out.—Charles Latour, Jr., Plattsburg, N. Y.

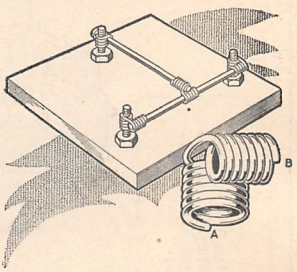


Do Not Press Condenser Dials for Fine Tuning

Many radio fans have discovered that by simply pressing on the edge of the condenser dial one station can be tuned in and another out. This is extremely bad practice, and if persisted in will ultimately ruin the bearing of the condenser. The method is successful only where the two stations are close together in frequency and are crowded on the dial settings. A vernier, or slow motion, dial will have the same effect and will not injure the condenser. It is a tuning mechanism which will move the rotary plates of the condenser very slowly over the smallest possible distance, necessary to tune the receiver sharply and separate the stations.

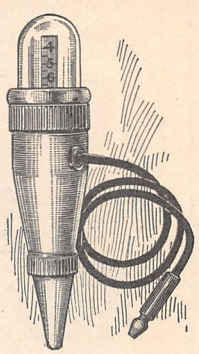
Spring Connector Eliminates Soldering

A spiral-spring wire connector has lately made its appearance on the English market. The spring has two branches, bent to a right angle, the unconnected ends of which are somewhat larger in diameter than the inner ones. In use, the end A is screwed down over the bolt projecting below the panel, and because of the taper of the coil, it will fit tightly, in fact, can only be removed with a pair of pliers. The other branch, B, receives the connecting wire or busbar, as indicated. It, too, is inserted by a screwing motion. As the connecting wire is under great pressure when in position, a good electrical contact is assured. The connectors are made to fit standard busbar, wire and threads.

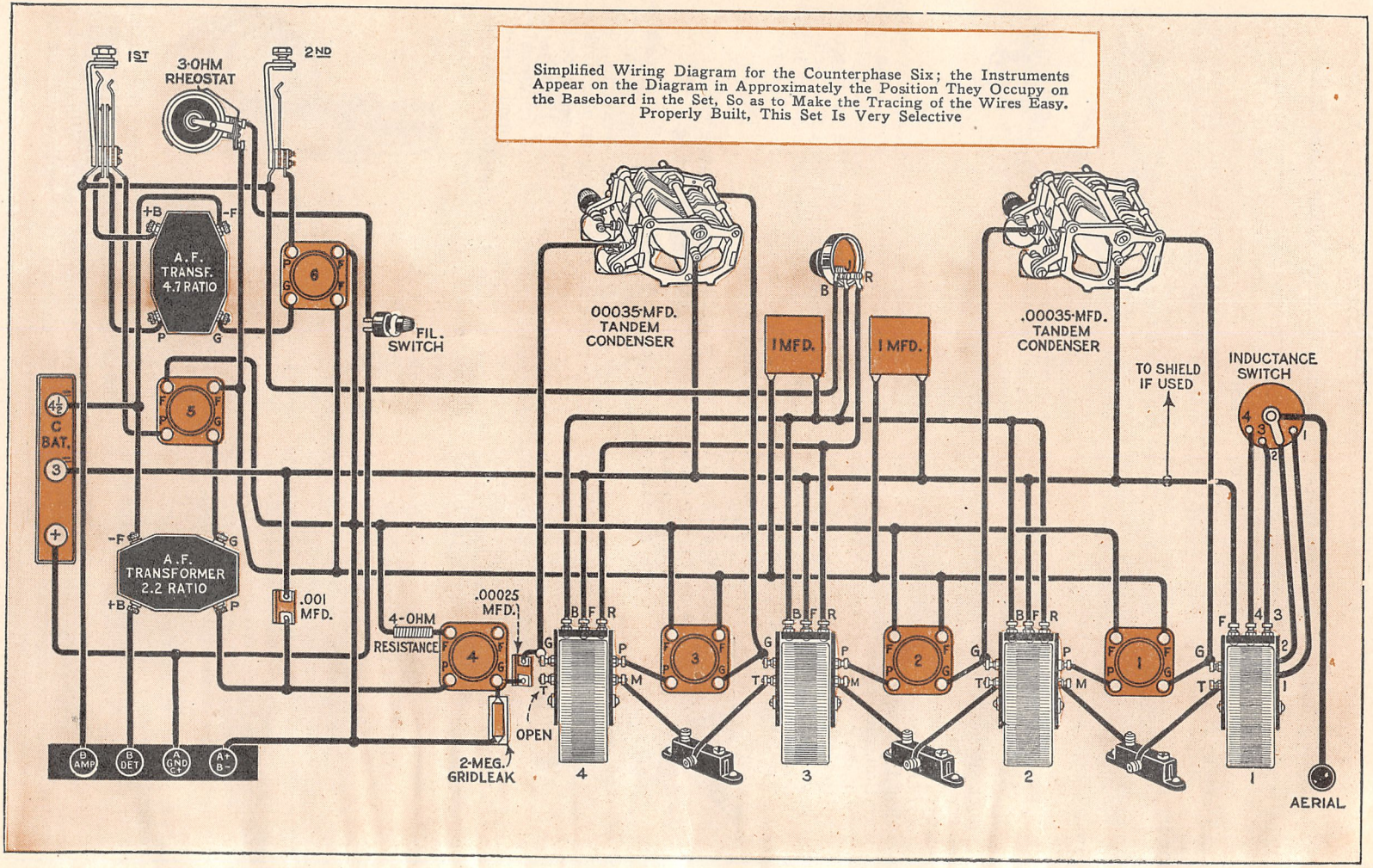


Bobber Battery Gauge Gives Voltage Reading

A bobber battery gauge that gives the true voltage reading of the A-battery when placed across the terminals, has lately made its appearance on the market. This method has its advantages over the hydrometer method in that there is no danger of spilling the acid solution on rugs and carpets. It is claimed that the voltage reading is preferable to specific-gravity reading owing to the fact that if the acid solution is too strong, the hydrometer will show a good charge, while in reality the voltage or pressure would not be up to the necessary point. To test the battery with the bobber gauge, turn on all the tubes in the set, and while taking the maximum load from the battery, the reading is taken across the A-battery terminals, showing the actual charge of the battery in voltage under operating conditions. The bobber gauge reads as low as 3¾ volts. When the battery is charged, the reading will be approximately 6½ volts.



Simplified Wiring Diagram for the Counterphase Six; the Instruments Appear on the Diagram in Approximately the Position They Occupy on the Baseboard in the Set, So as to Make the Tracing of the Wires Easy. Properly Built, This Set Is Very Selective



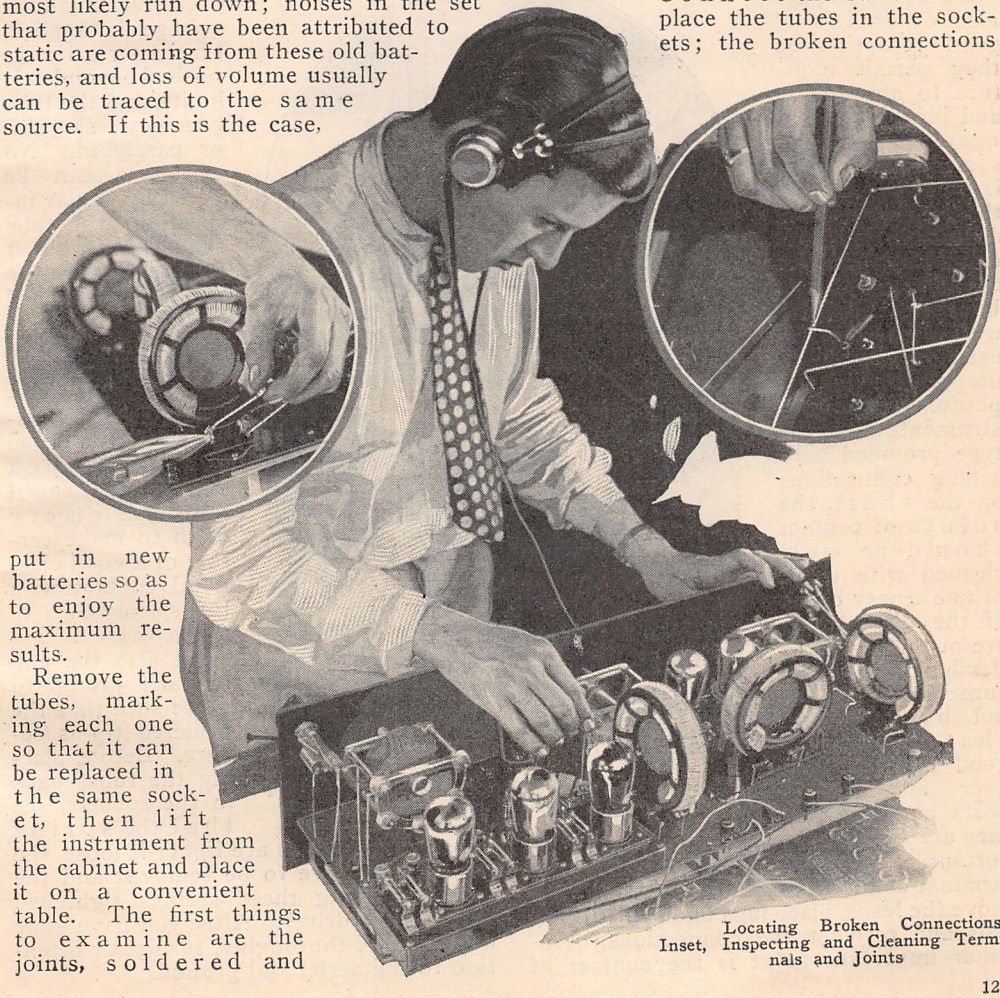
Getting Ready for Winter DX

By JOHN R. SMYTHE

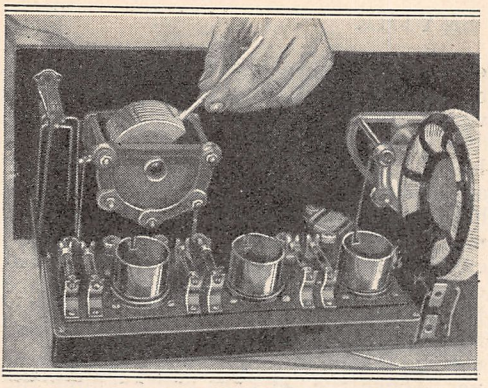
WINTERTIME brings the distant stations closer, and the cold clear evenings bring back old friends that have been buried under the summer static, if—and it is a big IF—the set is in proper condition for the best reception. Inspecting the radio set is just as important as automobile inspection. It is sometimes put off until increasingly poor results make it absolutely necessary. Good results depend on first-class equipment kept in working order, and a little attention to these details pays in increased range, better volume, and longer service from the instrument.

Since the set was last overhauled, the vacuum tubes have been burning some 500 or 600 hours. The batteries, especially the B-batteries, have been delivering current over a long period and are most likely run down; noises in the set that probably have been attributed to static are coming from these old batteries, and loss of volume usually can be traced to the same source. If this is the case, put in new batteries so as to enjoy the maximum results.

Remove the tubes, marking each one so that it can be replaced in the same socket, then lift the instrument from the cabinet and place it on a convenient table. The first things to examine are the joints, soldered and otherwise, as these are a common source of trouble unless the work has been done very carefully. Many times, too much flux has been used and this has run in behind the terminal, forming a high-resistance path, or if the wrong kind of flux has been used, corrosion takes place. Remove the terminal nut and clean with a cloth moistened with alcohol and placed over the end of a screwdriver. Replace the nut and tighten firmly. The terminals on the coils, transformers and tube sockets should all be gone over in this manner. Turn the set over and examine the connections; see that each connecting wire is tightly soldered, and that no wire has been bent so as to touch another; each loose joint here should be carefully soldered. Broken joints can be accurately located by operating the set temporarily. Connect the batteries and place the tubes in the sockets; the broken connections



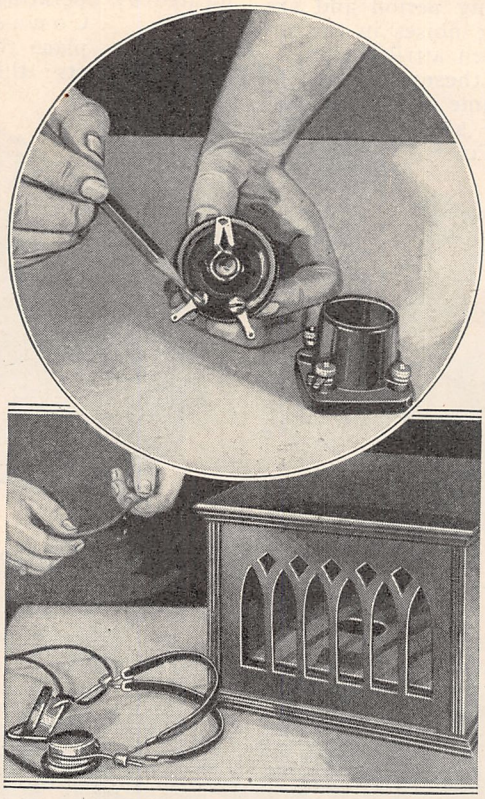
Locating Broken Connections; Inset, Inspecting and Cleaning Terminals and Joints



A Pipe Cleaner Provides the Best Cleaner for Variable-Condenser Plates

can then be located while the set is in actual use by tapping or moving each joint in turn and listening for noises in the headphones.

Dust and dirt are also enemies of good reception as they permit moisture to accumulate and introduce leakage causing troublesome noises. This is especially true in the variable condensers, where dust will gather between the plates; it can be easily removed with a pipe cleaner, used in the manner shown in the photo. If these instruments are of the type provided with wiping connections on the shaft, the points of contact should be well cleaned with a bit of fine emery cloth. If the connections are of the pigtail or flexible type, make sure that they are not broken and that they make good contact. Go over all binding posts and see that they are tight. The rheostats are very important to good operation; examine the terminal connections, and, if corroded, remove the leads, place lugs under the terminals and resolder the connections. Another important point is the contact of the wiping arm on the resistance winding of the rheostat. If this arm does not make good contact at all points on the wire, poor results are certain; if not, remove the setscrew, bend the arm slightly and replace on the shaft.



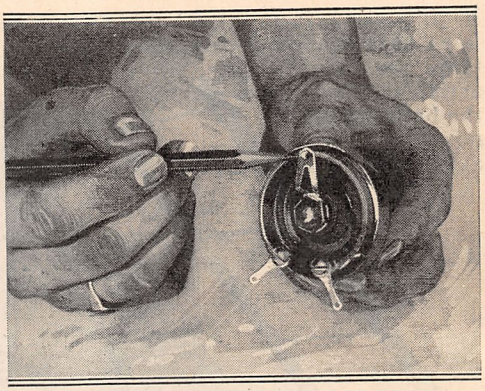
Lugs on Rheostats and Sockets Must Be Tight and Clean; Below, Inspecting Phone and Speaker Cords

Phone and loud-speaker cords in average service should be renewed once a year as the constant twisting of these cords breaks the fine tinsel conductor and causes noises. They are not expensive and are easily replaced.

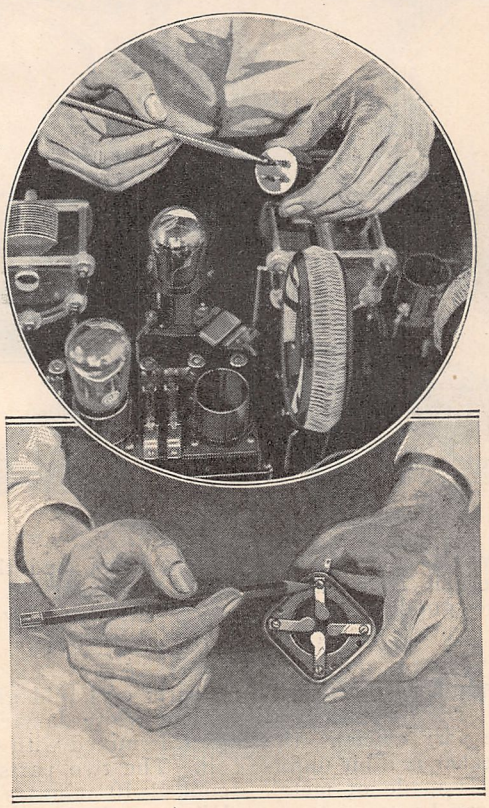
Good tubes are all-important; if they have been in use for some time, they should be tested. Some will be found much better than others, and the poor ones can usually be rejuvenated, if they are of the standard type, such as the UV-201A or C-301A; this also applies to the UV-199 and the C-299 types. A good tube has an average life of about 1,000 hours, but when excessive filament voltage is applied, the strain is pushed beyond safe limits, and the tube becomes sluggish or paralyzed. No change can be noted by ocular inspection; the tube still lights, but it fails to produce the results obtained before.

Another important point that should not be neglected is examination of the tube prongs. Each should be cleaned with fine emery cloth to make certain of a good electrical contact with the spring clips in the socket. Inspect also the end of each prong, to make sure that the soldered tip is secure. Before placing the tubes back in the sockets, see that the spring clips in the sockets are tight; if loose, the socket may have to be removed and the screws holding these springs tightened with a screwdriver. After you have gone over the set thoroughly, turn your attention to the aerial and ground.

No set will work well on a poor aerial and inefficient ground. The superheterodyne and other types of receivers using loop aerials are practically free from trouble of this nature, unless there is a loose connection, but with the outdoor type of aerial conditions are different. Summer storms may have rendered the aerial ineffective; it may be touching the building, the wire may be broken; lead-in wires may have rubbed against the building, damaging the insulation and causing shorts, especially during damp weather. If the aerial was installed temporarily, it may be that the connections were made without soldering and corrosion has taken place. Solder the connections at the insulators and at the point where the lead-in wire is connected to the main wire. It is best to make a new joint, first carefully scraping all corrosion from the wire. After the joint has been soldered, wrap it with electrical friction tape. This will insure a good electrical connection that will not be affected by the weather. If the aerial has sagged, this slack should be taken up, as a swinging aerial will give poor results and increase the chances for shorts against the building. Inspect the lead-in to the set and see that it is well insulated and in good condition. No. 14 weather-proofed copper wire makes a very good lead-in and should run as directly as possible to the point where it is taken into the building.



The Wiping Arm on the Rheostat Must Make Good Contact with the Winding



Above, Inspect Tubes for Loose Prongs; Below, See That the Socket Contacts Are Tight

The best ground is obtained on a cold-water pipe, the pipe being filed bright and the wire securely fastened to it by means of a ground clamp. Even if this was done when the set was first installed, it is a good idea to remove the clamp and brighten it on the inside with emery cloth, polishing also the contact surface on the pipe before replacing the clamp. If a water-pipe is not handy, a good ground can be obtained by driving a length of pipe into the soil outside of the building; select a damp spot at a point near the window closest to the set, and fasten the clamp to this pipe. Iron rod can be used if pipe is not available. More elaborate grounds can be obtained by burying metal sheets, or if the aerial is of the overhead type and it is possible to use a counterpoise consisting of several wires strung below the aerial, even better results can be obtained. An approved lightning arrester should be used with all types of outside aerials, and it is necessary to use well-insulated wire run through porcelain-tube insulators where the wire enters the building, continuing this wire to the set. Do not run outside aerials near high-tension wires. If such wires are near the building, run the aerial at right angles to them in all cases. Many humming noises and crackling sounds are attributed to the set which are really caused

by induction from near-by high-tension lines that are paralleling the aerial. If there are other aerial wires on the building, do not run your aerial close to them. Keep as far away as possible, and at right angles, if there is room, above or below them. Use good materials; this is important and will always give better satisfaction in the long run. A well-installed aerial and ground need little attention and pay big dividends in good results.

These things take little longer to do than the time required to tell about them, and the fan who has done them can go ahead with his "DXing" assured that his only enemy will be static.

Take the Slack Out of the Antenna, and See That the Lead-In Is in Good Condition; Inserts, Soldering and Taping Aerial Joints

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Finishing a Homemade Loud Speaker

Although it may be very efficient, the average homemade speaker is a bit unfinished in appearance. If made of metal, cardboard or wood it can be very attractively finished by using either the clipped-wool or the blistered effect so often seen. The latter is a little easier to keep clean.

To make the blistered effect, a glue and whiting "dope" is used. This dope is made in the following way: First mix 10 parts of finest gilders' whiting with cold water until a thick cream is formed; to this, add 6 parts of liquid glue. In another container, white damar turpentine varnish, 1 part, is mixed with 4 parts of raw linseed oil. The two parts are then mixed and cooked 10 minutes in a double cooker. When cool, the mixture should have the consistency of very soft butter. Pour this into a wide-mouthed jar and use the following day. This dope is the old foundation for polychrome work and works better after standing for a day.

The speaker should first be given a thorough application of shellac; uncovered spots will not hold the polychrome dope.

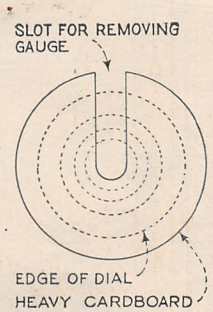
The dope, if of the right consistency, will flow from the brush. If it is too thick, add water drop by drop, and if it is too thin, set the jar, with the lid off, in hot water to evaporate some liquid.

Spread the dope over the speaker with a spatula or broad soft brush. It is best to do one side at a time, as it is a pretty sticky job. Go over the inside surface with a tapping motion. This must be done until the surface assumes a blistered effect. The coating should be allowed to dry for two or three days and the outside is then treated. After drying another three days, the whole surface is given a coat of shellac. For the final finish the speaker may be given two or three coats of colored varnish or of flat paint, to match the interior of the room.

The clipped-wool finish is a little easier and more quickly done. The speaker is first given a coat of shellac and, when dry, is given a rather heavy coat of turpentine damar varnish on the inside. This is a very sticky job. While still very wet, sift on the varnish sign painters' flock. Apply the flock until the surface is evenly covered. This will give a velvety surface that is very good. When perfectly dry, finish the outside of the trumpet in the same manner. If the soft finish is not wanted, a semi-glossy effect can be had by painting over with a thin varnish, after the varnish holding the flock has dried. Do not attempt to hurry the work.

Spacing Dials from Panel

A simple form for spacing the dial from the panel when assembling the set, aids the builder to maintain an equal distance between the dial and panel, at all points. This gauge is made from heavy cardboard and should be large enough to extend about ½ in. beyond the edge of the dial. A slot is then cut to fit around the shaft of the condenser, coupler or variometer, as the case may be. Place the gauge on the shaft next to the panel, and then fit the dial against the form and tighten the setscrew. Then pull out the cardboard. By using this method all dials will be correctly spaced, and will not rub against the panel when rotated.—H. Ray Eaton, Pittsfield, Mass.



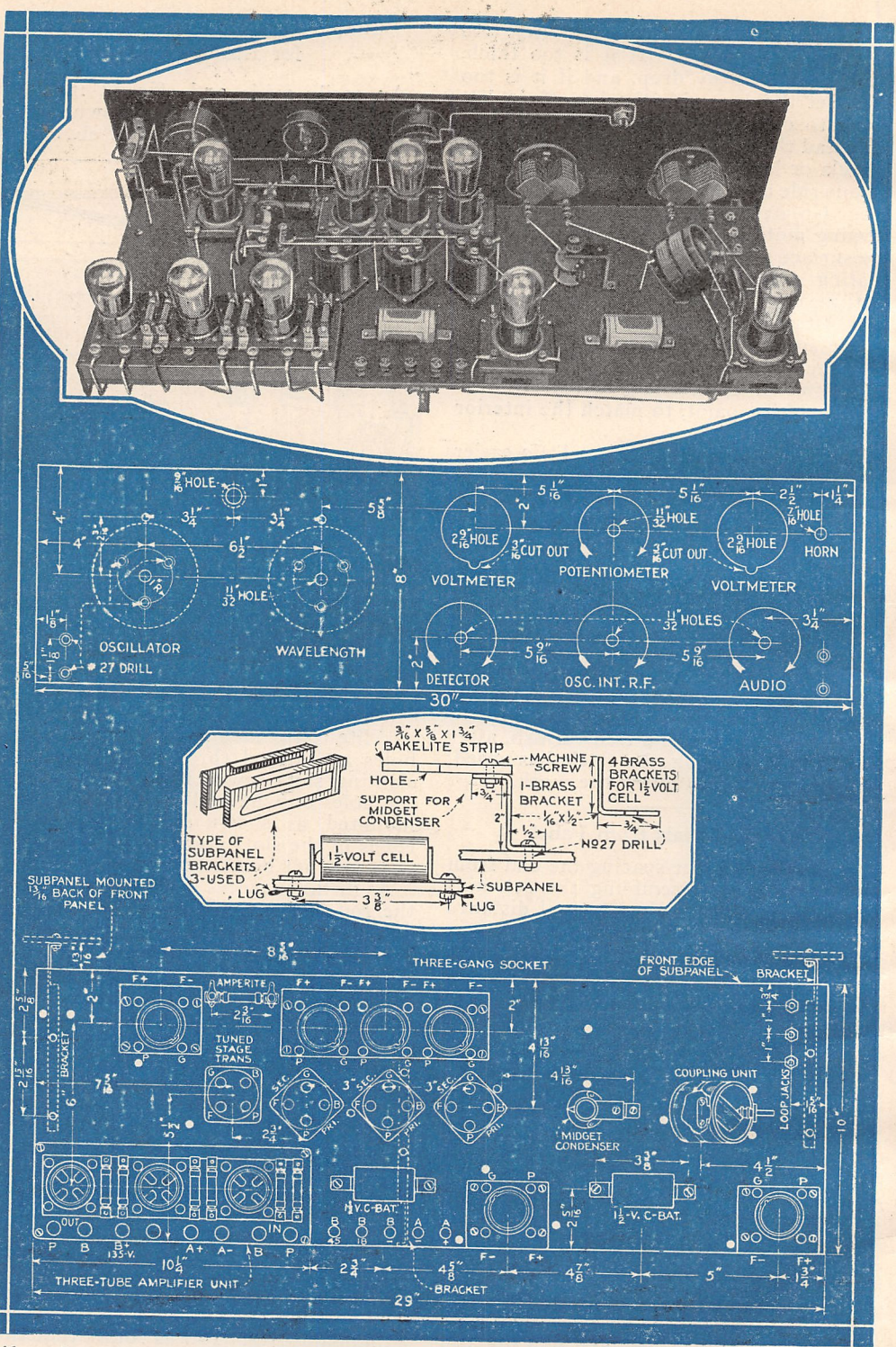
Simple Insulator and Mounting for Inside Aerial

An easily made and efficient insulator for the indoor antenna is shown in the illustration. A short length of ebonite or bakelite rod is filed flat at the ends; next, holes are drilled through its center and slanting slots sawed from the outside to the holes on what will be the inside when mounted, as shown in the detail. The edges of the slots are rounded so that the wire will not bend at sharp angles.

Simple Indoor Aerial Supported by Ebonite Rods; Lower Right, Detail of Construction

As distance pieces between the wall and the rod, porcelain insulators of the common commercial type are used. The latter should be long enough to keep the wire several inches from the wall, the mounting screws passing through the ends of the ebonite rod and the insulators. A triangular aerial, as shown in the illustration, uses a minimum number of insulators, and gives the greatest length of aerial wire. In addition, such an aerial is non-directional, and receives equally well from all directions. The aerial should be kept about one foot below the ceiling, or even more if it can be arranged.—C. A. Oldroyd, Barrow-in-Furness, Eng.

¶A wavelength of only 6 ft. has been used by station FL, Eiffel tower, France, successfully over a distance of two miles. The antenna current used did not exceed 30 milliamperes. It was found that these short wavelengths were free from static disturbances.



Above, Rear View of the Completed Set, Ready for the Cabinet; Below, Front and Subpanel Layouts and Details of Brackets

Great Range, Ease in Tuning and Simplicity of Construction Also Feature 1926 Model Set

By F. L. BRITTIN

THE instrument described in this article is a further development of the well-known Popular Mechanics' Superheterodyne Eight, which has given real satisfaction to thousands of fans both in this country and abroad. Practically all the parts are the same, but the circuit has been greatly improved, and a resistance-coupled amplifier replaces the a.f. transformers, resulting in even better tonal qualities. The new model sets a standard for volume, range, tone and selectivity that will be difficult to surpass for some time, and gives the broadcast listener a new conception of what receivers should be.

Simplicity of design makes the new set especially interesting to those with limited experience. The front panel and subpanel are larger than in the former set, providing ample room for the instruments, which are so arranged that shielding is unnecessary. Before attempting to build the instrument, look over the diagrams carefully and provide all parts just as specified in the material list; take time to do good work and follow the instructions in the order they are given.

The layout for the subpanel is given at the bottom of the opposite page. Place this panel on the table and arrange the instruments in the positions shown in the diagram, with all terminals exactly as indicated; then, holding each instrument firmly in place on the panel, point off each mounting hole with an icepick or other sharp instrument, and before removing the sockets and other instruments from the panel, point off the holes indicated by the white dots. These holes are required for running the leads below the subpanel and only the most important points are indicated, as the other holes can be drilled later, as required. Point off the holes for the mounting brackets and other instruments carefully. All holes in this panel then can be drilled with a No. 27 drill except the three holes for the loop jacks where ⅜-in. holes are required. The subpanel brackets are a standard type that can be obtained from any dealer; these raise the subpanel 2 in. and permit easy wiring under it, resulting in short direct leads. Three brackets are used, one at each end and one reversed and mounted in the center of the panel at the rear. The flat ends of the two end brackets, in which screw holes will be noted, are mounted toward the front and extend 1 3/16 in. beyond the panel; each of these brackets is ⅝ in. from each end of the panel. The center bracket at the rear is mounted with the flat end flush with the rear edge of the panel. Round-head brass machine screws, 6-32 by ½ in., are used to mount the brackets, as well as for most of the other instruments; screws 1½ in. long will be necessary for the tube sockets and the amplifier unit.

The bracket for mounting the midget condenser is shown in detail in the diagram, also the four small brackets used for mounting the 1½-volt dry cells; these brackets are all made from a 10¼-in. strip of 1/16-in. brass ½ in. wide. The brackets for the 1½-volt cells are mounted 3⅜ in. apart and are bent so as to hold the cell tightly in place and make good contact on the cell base and the brass positive terminal at the opposite end. Refer now to the large wiring diagram, and mark these brackets positive and negative in their proper order, so that there will be no error later. The amperite unit, mounted between the second detector and the three-gang socket, is an automatic filament control for the second detector tube, and eliminates a rheostat at this point. The .00025-mfd. condenser is mounted on the metal brackets supplied with the tuned-stage transformer and placed across the secondary terminals; a similar bracket is supplied for the .0005-mfd. grid condenser, which also carries the gridleak in clips; this bracket is mounted on the grid terminal. The A and B-battery binding

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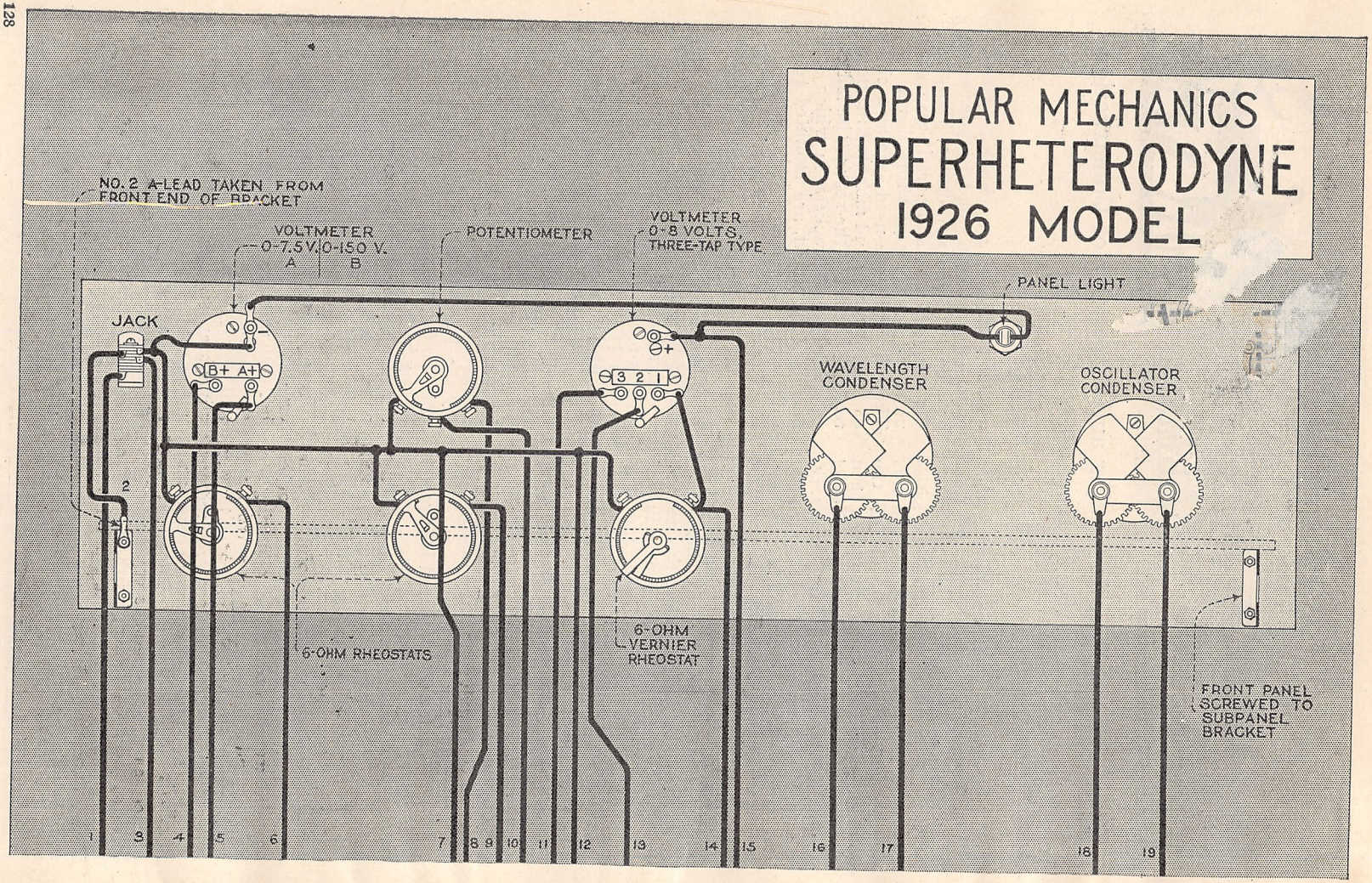
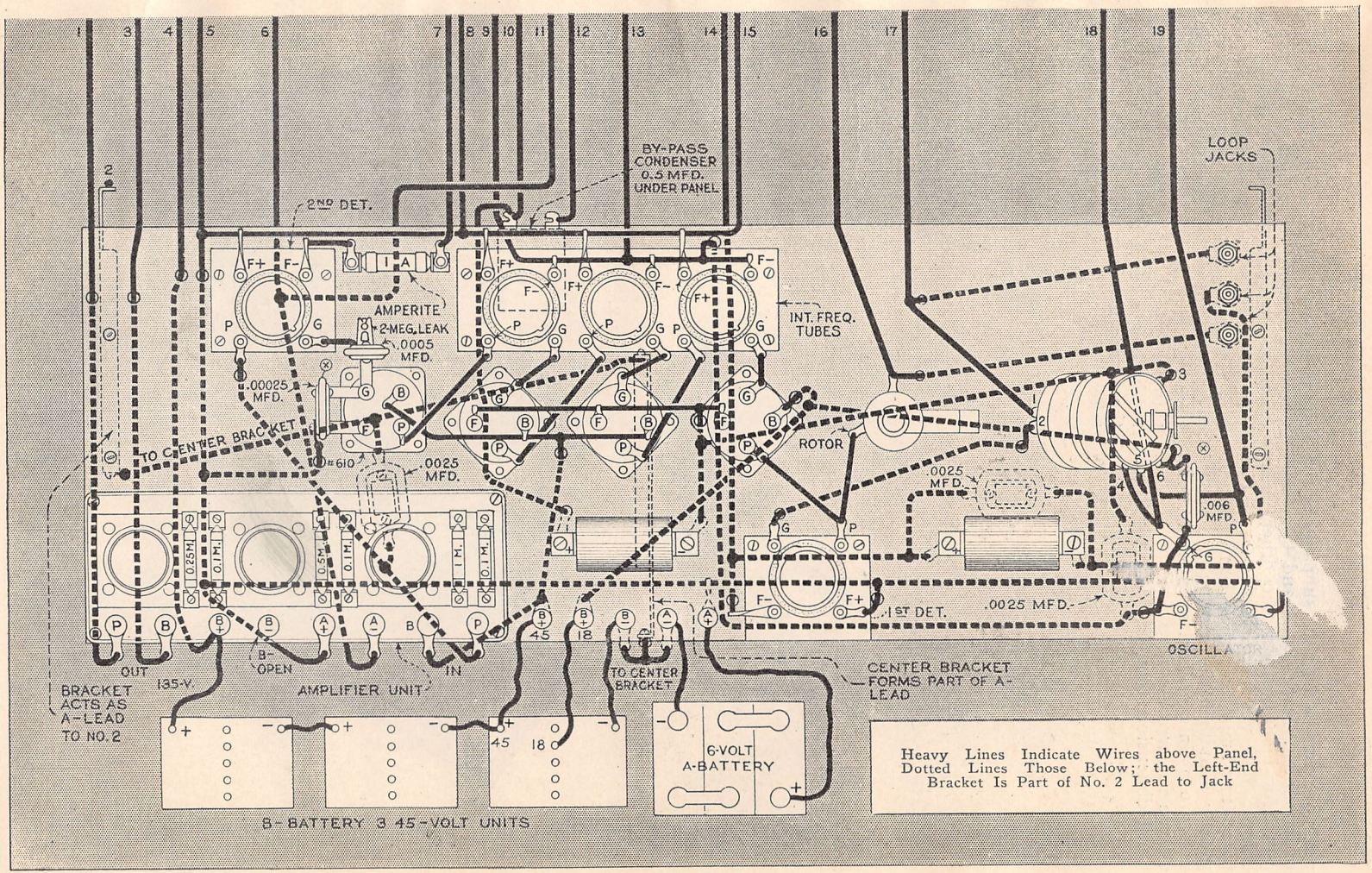

POPULAR MECHANICS
SUPERHETERODYNE
1926 MODEL
NO. 2 A-LEAD TAKEN FROM FRONT END OF BRACKET
VOLTMETER 0-7.5 V. A, 0-150 V. B
POTENTIOMETER
VOLTMETER 0-8 VOLTS, THREE-TAP TYPE
PANEL LIGHT
JACK
B+ A+
3 2 1
WAVELENGTH CONDENSER
OSCILLATOR CONDENSER
6-OHM RHEOSTATS
6-OHM VERNIER RHEOSTAT
FRONT PANEL SCREWED TO SUBPANEL BRACKET
1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19


1
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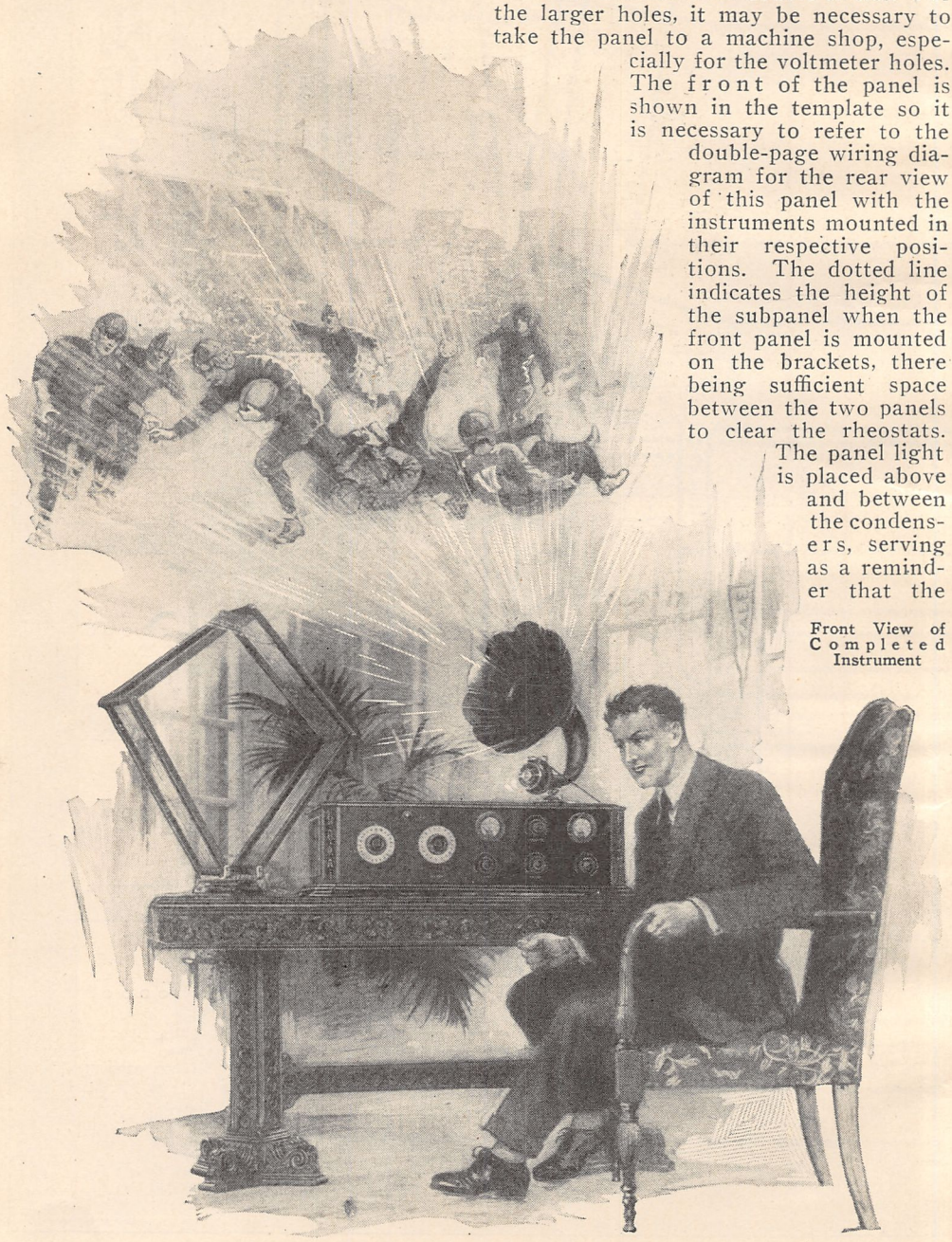
2
BY-PASS CONDENSER 0.5 MFD. UNDER PANEL
LOOP JACKS
2ND DET.
AMPERITE
2-MEG. LEAK
.0005 MFD.
.00025 MFD.
INT. FREQ. TUBES
TO CENTER BRACKET
#610
.0025 MFD.
ROTOR
.0025 MFD.
.006 MFD.
1ST DET.
.0025 MFD.
OSCILLA
CENTER BRACKET FORMS PART OF A-LEAD
BRACKET ACTS AS A-LEAD TO NO. 2
OUT
135-V.
B-
OPEN
AMPLIFIER UNIT
IN
TO CENTER BRACKET
45
18
6-VOLT A-BATTERY
B-BATTERY 3 45-VOLT UNITS
Heavy Lines Indicate Wires above Panel, Dotted Lines Those Below; the Left-End Bracket Is Part of No. 2 Lead to Jack

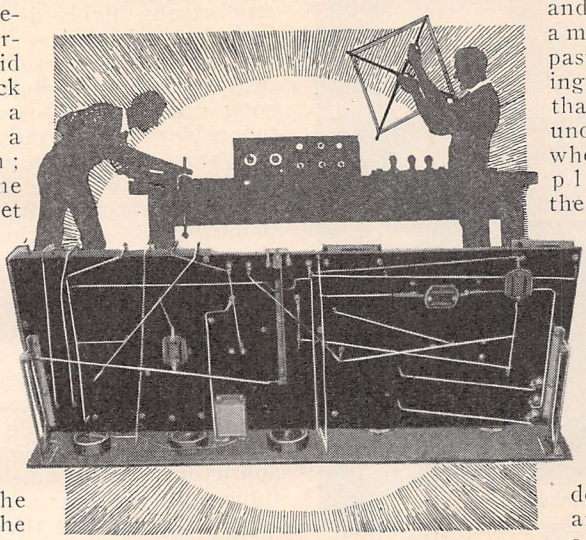
posts are mounted on the subpanel in the order shown. Mark the 18 and 45-volt B-posts for identification; the other posts can be had with engraved tops. The three-tube amplifier unit is complete and greatly simplifies the wiring; the terminals are plainly marked so there is little chance for error.

All dimensions for the front panel are plainly shown. This panel should be laid out with care, and it is best to prepare a cardboard template the exact size of the panel. Clamp this to the panel with two or more C-clamps and point off the holes to be drilled carefully, marking the panel deeply so that the drill will not creep and throw the hole out of line. Countersink the holes marked with double circles. For the larger holes, it may be necessary to take the panel to a machine shop, especially for the voltmeter holes. The front of the panel is shown in the template so it is necessary to refer to the double-page wiring diagram for the rear view of this panel with the instruments mounted in their respective positions. The dotted line indicates the height of the subpanel when the front panel is mounted on the brackets, there being sufficient space between the two panels to clear the rheostats. The panel light is placed above and between the condensers, serving as a reminder that the



Front View of Completed Instrument

tubes are lighted and also as a tuning light for the dials, which is useful at times. The horn jack shown in the upper left-hand corner is detailed in one of the illustrations, and each spring in it is numbered to correspond with the circuit wires to avoid error. This jack functions both as a horn jack and a filament switch; plugging in the horn places the set in operation, and to shut the set off, the plug must be withdrawn, which is a further check on the operator to remind him not to leave the set turned on, needlessly using the batteries when the set is left alone.



View of Underside of Panel; Note the Position of the Condensers

This, of course, puts all the tubes in use at once, but volume can be controlled with vernier detector rheostat, if a UV-200 or C-300 tube is used for the first detector, or practically the same result can be had by detuning, if a UV-201A or C-301A tube is used. All other tubes are of the A-type. For those who prefer to operate the set at times with a minimum number of tubes, a simple switching device that can easily be mounted on the front panel will be described in an early issue. The set is now ready for wiring.

The wiring diagram is as simple as it is possible to make it, and all wires are shown in their exact positions both above and below the subpanel, the panels being separated to show the wiring more clearly. The wires are numbered so that each lead can be easily traced from page to page; the black lines indicate the wires above the subpanel and the dotted lines show the position of the wires below. Wire No. 4, running from the B-positive 135-volt terminal on the amplifier unit to the B-positive terminal on the A and B-battery voltmeter, is a flexible rubber-covered lead, No. 14 round tinned-copper busbar wire being used for the remainder of the circuit. Very little spaghetti insulation is used; only a few short lengths are necessary under the subpanel where wires are likely to be shorted if moved out of place. Soldering lugs are used under every terminal where a wire is to be connected. The lugs are fastened to the small fixed condensers with short brass machine screws. Lugs are very important; do not fail to employ them, and use solid wire solder and a very small amount of flux paste, carefully wiping the flux off so that it will not run under the terminal when the iron is applied. Note how the wires are run from the instruments on the subpanel down through holes and continuing to their respective terminals. Do not change the direction of these leads under the panel; they are so placed as to avoid forming loops in the circuit, which would cause detrimental effects in the set. Several by-pass condensers are mounted below the subpanel, and are indicated by the dotted lines; these condensers are clearly shown in the under-panel photo. Note that the .5-mfd. by-pass condenser is mounted on the underside at the front by means of two short brass machine screws, the soldering terminals extending just beyond the edge of the panel. Now, mount the front panel on the subpanel brackets, place a soldering lug under the nut at the point marked for wire No. 2. This is for the A-negative lead, of which the left-end bracket and the center bracket are a part. Soldering lugs are mounted on the ends of the brackets with short brass machine screws, and the dotted line clearly shows the lead connecting the brackets. The A-negative and B-negative binding posts are connected to each other and then to a lug mounted on the rear end of the center bracket. The 2-in. space below the subpanel provides ample room for all wires without crowding, and leads crossing each other can be well separated. Note the lead running from the negative of the 1½-volt cell to the center loop jack; the center loop lead will be plugged into this jack when the set is hooked up for operation. The A and B-batteries and their connections are so clearly shown that little explanation is

necessary. The B-batteries should be of the large 45-volt type, and are connected in series to obtain a total of 135 volts for

Side View of Jack, with Springs Numbered to Correspond to Diagram

the amplifier unit, the 18 and 45-volt taps being taken from the first 45-volt unit as shown. Note that the B-negative post on the amplifier unit has no connection. The loop may be of any good make, but must be provided with a center lead. Flexible, well-insulated leads not over 3 ft. long—shorter if possible—are connected to the loop. These leads terminate in small plugs of the cord-tip type, and are plugged into the loop jacks, the center lead to the center jack. Plug in the horn and place one tube successively in each socket, after connecting the batteries, turning up the rheostats to see that the filament circuit is correctly wired. Facing the set, the audio rheostat is the one on the extreme right; it controls the filament voltage for the amplifier tubes only. This voltage can be checked by point 3 on the three-tap voltmeter. The second detector tube is automatically controlled by the amperite, and the center rheostat is for the oscillator tube and three intermediate-frequency tubes in the three-gang socket; this voltage is checked on point 2 of the voltmeter. The first detector tube is controlled by the vernier rheostat and is checked at point 1 on the voltmeter. After testing the filament circuit, place all of the tubes in the sockets, and the set is ready for operation.

Operating a superheterodyne receiver correctly, so as to obtain maximum results, requires a little practice. This is true of any highly developed instrument—the experienced operator has the advantage; however, the operation of the instrument is so simple that anyone can soon tune in stations at surprising distances with good tone and volume. Set the rotor of the coupling unit at an angle of about 45°, and the set can be adjusted under operating conditions. Set the pointer knobs of all rheostats so that the rheostat is at the off position when turned to the extreme left. A small setscrew in the knob is then tightened on the shaft, and the pointer on the potentiometer knob is fastened in the same manner. To tune in a station, first set the potentiometer about one quarter of the way up from the lower-left side, then turn up the rheostats slowly, keeping the pointers at approximately the same position, and continue until you hear a soft hum from the tubes. Second, set the wavelength condenser at any given point, say 30°, and rotate the dial of the oscillator condenser very slowly 10 to 15° on each side of the 30° mark; if a click or whistle, indicating the presence of waves from a station, is heard, but the words or music is not clear, turn up the detector rheostat slightly, or shift the potentiometer either forward or back, to clear the signal. The potentiometer will have a certain setting where all stations come in best, this point always being found to the left of center. The rheostats will also have a more or less fixed setting that will give the best results, and the tuning is then almost entirely confined to the condenser dials. Third, if nothing is picked up at the first setting of the condensers, move the wavelength condenser up 10°, and again rotate the oscillator dial slowly as before on either side of the 40° mark, continuing this process until a station is picked up. Shift the position of the loop from time to time, as this will often enable stations to be picked up that otherwise would not be heard. When a distant station is picked up and tuned in to best advantage, set the little midget condenser to the point where the signals come in with the best volume and clarity; also make any slight adjustment of the coupling unit rotor that may be necessary to get the loosest coupling without approaching the breaking-over point too closely.

These last-mentioned adjustments need only be made once, and best results are

obtained if they are left alone after the proper setting is once determined.

Place the set in a cabinet or console having a depth of 12 in. measured from the front panel to the rear partition, drilling holes through the rear of the cabinet for the loop and battery leads; bore the holes for the leads about 1 in. apart. Use heavy, flexible rubber-covered auto-ignition wire for the A-battery leads, and lighter flexible well-insulated leads for the B-batteries.

A complete set of large blueprints, including full-size panel and subpanel drilling templates, instrument layout, and wiring diagram, as well as a schematic diagram of the circuit, may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago, for 75 cents. Specify blueprint No. 104.

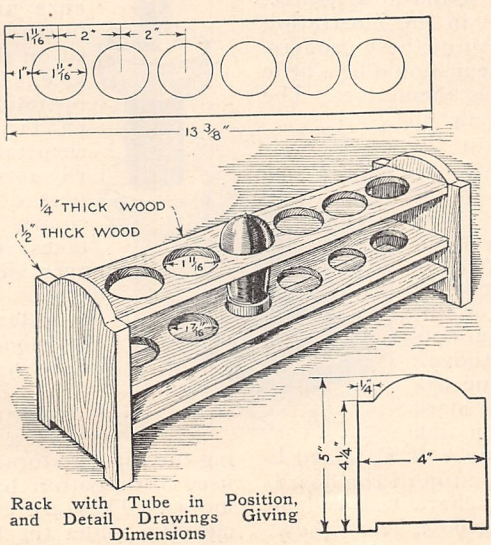
MATERIAL LIST

1 bakelite or formica panel, 3-16 by 8 by 30 in.
1 bakelite or formica subpanel, 3-16 by 10 by 29 in.
1 bakelite strip, 3-16 by ⅝ by 1¾ in.
1 brass strip, 1-16 by ½ in., 10¼ in. long.
3 Benjamin subpanel brackets.
3 No. 600 Remler intermediate-frequency transformers.
1 No. 610 Remler tuned-stage transformer.
1 No. 620 Remler coupling unit.
2 No. 631 Remler .0005-mfd. capacity unit, complete with dials.
1 three-gang, shock-absorber type socket unit, standard base.
3 single shock-absorber type sockets, standard base.
2 6-ohm rheostats, plain, one-hole mounting.
1 6-ohm rheostat, vernier, one-hole mounting.
1 400-ohm potentiometer, one-hole mounting.
1 filament-control jack. 1 1-A amperite.
1 No. 855 Chelton midget condenser, low-loss.
1 Daven super-amplifier unit complete (three-stage).
1 No. 55 Jewell voltmeter, 0 to 8 volts only, three-tap type.
1 No. 55 Jewell voltmeter, A and B-type, 0 to 7.5; 0 to 150 volts.
1 loop aerial, three-tap, (box-type preferred).
1 panel light.
1 2-meg. gridleak, cartridge type.
1 Sangamo condenser, .0005 mfd., with gridleak clips.
3 Sangamo condensers, .0025 mfd.
1 Sangamo condenser, .006 mfd.
1 Sangamo condenser, .00025 mfd.
1 Dubilier by-pass condenser, 0.5 mfd.
2 1½-volt dry cells (large size).
5 binding posts with engraved tops.
3 cord-tip jacks and plugs.

Handy Rack for Spare Tubes

Many good radio tubes have been ruined for lack of a safe place to keep them, and the simply constructed rack described herewith is therefore a worthwhile addition to the experimenter's equipment, and should be used even if the tubes are removed from a set for a few moments only. Anyone can make the rack at very little cost. Three pieces of hardwood, ¼ in. thick, 12 in. long and 3 in. wide, are required for the shelves. The position of these is shown in the drawing. The lower shelf serves as a support for the tube base, while the two upper ones are perforated to hold the bulbs snugly in an upright position. The holes in the top shelf are 1 11/16 in. in diameter, and those in the one below, 1 7/16 in. in diameter. Be sure the holes are spaced properly so that they will line up when the rack is assembled.

The two endpieces are of ½-in. stock; these should be 4 in. wide and 5 in. high at the highest point, the rounded top improving the appearance of the rack. These pieces may be grooved to take the shelves, which are then glued and tacked in place with small brads, or the shelves may be tacked directly to the ends, if preferred. After the rack is assembled, it should be sandpapered and varnished. It is a good plan to screw the rack to the table.—C. A. Reberger, Roselle Park, N. J.

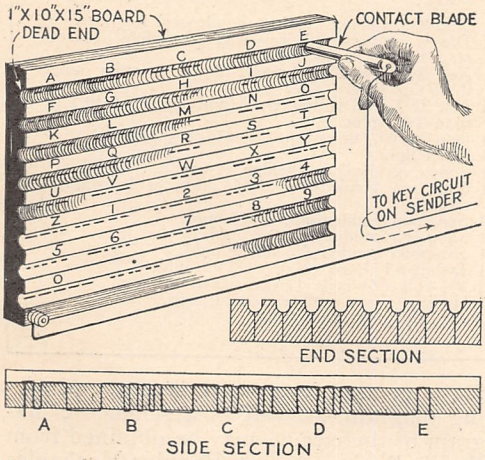


Rack with Tube in Position, and Detail Drawings Giving Dimensions

¶The tone of incoming signals can be improved considerably by shunting the primary of the first audio-frequency amplifying transformer with a fixed condenser of .001 mfd. capacity.

Making a Wireless-Signal Board for Code Practice

A radio-signal board for the beginner who is learning the code will prove a great help. With it, the necessity for listening



Wireless Code Board Which Transmits Signals Automatically; the Construction Is Clearly Shown

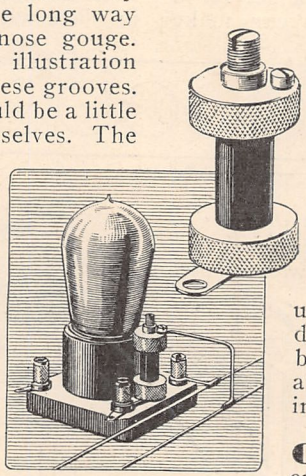
in is eliminated, and the speed can be regulated to suit the operator. A device of this type was used years ago by telegraph operators, and the one described is a simplified form of this, which will meet the need of the radio amateur. It can be used instead of a key for sending messages if desired, or connected to a buzzer for code practice.

Use a board, 15 in. long, 10 in. wide and 1 in. thick, preferably of oak or ash. Lay off eight parallel grooves, the long way of the board, with a round-nose gouge. The end section given in the illustration shows the relative depth of these grooves. The spaces between them should be a little wider than the grooves themselves. The wireless signals are made up of dots and dashes, so the idea is to arrange long and short metal contacts in the grooves to correspond with the individual code signals. This is done by threading soft copper wire through the board as indicated. For this purpose, mark off the dots and dashes in the grooves. Five characters to a line will be about right; then mark the character itself in ink above the groove. Thus A, B, C, D and E will be written along the top of the board, and the corresponding characters will be drawn in pencil in the groove below them.

Now, with a small drill, bore vertically through the wood at the ends of each dash and dot, being careful to keep the holes apart through their entire depth. The board is now ready for wiring. Starting at A, push the end of the wire up through the first hole from the bottom and down through the second. This makes a short line or dot. Then push the wire up again in the next hole and down through the following. This makes a dash, and with the previous dot forms the code signal for the letter "A." Continue this threading process throughout the entire board, pulling the wire taut at all times and flatting it in the grooves with a dull tool. The end of the wire should come out at the lower left-hand corner of the board where it is fastened to a binding post. The end started at A should be left open, or dead. Remember to use one continuous wire throughout.

Connect the binding post to one side of the key or buzzer, and the other wire from the circuit to a dull-edged piece of metal, called the contact blade, which should slide freely in the grooves. It should also be insulated for part of its length to form a finger hold for the operator. With the circuit ready for sending, simply draw the blade slowly across the contacts under the letter to be transmitted. Its longer or shorter contact with the wire in the groove means a dot or a dash, automatically sending the letters.

Adjustable Resistance Unit Replaces Amplifier Rheostats



A simple adjustable resistance unit that can be used instead of rheostats mounted on the panel is now available. It simplifies the operation of the set by eliminating panel-controlled rheostats, and being mounted upright on the filament post of the tube socket, as shown in the illustration, takes very little space. The upper view shows the unit in detail. The adjustment can be instantly changed to suit any tube, the resistance ranging from .2 to 35 ohms.

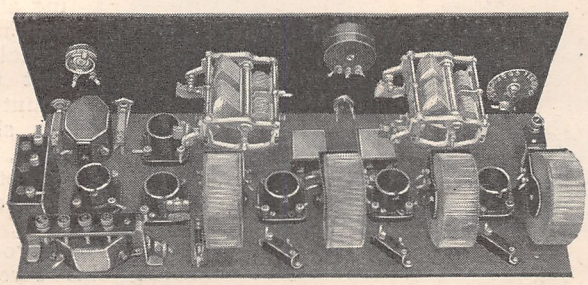
¶A pair of electrician's tweezers are a convenience in keeping the tops of storage batteries dry, when used with cotton batting and weak ammonia. They are especially useful when cleaning under the lugs of B-batteries.

This Six-Tube Set Is Highly Selective

Counterphase Receiver Has Good Range and Volume Also, and Can Be Used on Fifteen-Foot Indoor Aerial

THIS circuit has been tested in Popular Mechanics radio laboratory along with several other circuits to find one that would meet the demand for selectivity without resorting to the superheterodyne method. During the tests we were able to bring in a number of outside stations through the Chicago ones, cutting out the locals at will, which can be said of very few circuits, other than the superheterodyne. The set is not difficult to build, and the cost low considering the results.

When the radio-amplification stages of a receiver are tuned to the same frequency, there is a tendency to oscillate. In this set, this is prevented by a separate counterphase circuit in each stage, which is permanently regulated by means of a small adjustable condenser to suit the tube used. In order to secure panel adjustment of the sensitivity, or tendency to oscillate, these circuits are controlled by a special double-resistance unit. Selectivity is governed by the degree of coupling between the aerial and the first coil. The inductance switch is used to regulate the number of turns through which the aerial current passes, from 2 to 25 turns as desired. The circuit is designed for the UV-201A or C-301A tubes throughout, including the detector tube. When this type of tube is used as a detector, it operates most efficiently at a low brilliancy; therefore a 4-ohm fixed resistance is placed in series with the positive detector filament. Before drilling the front panel, note the two 3/16-in. holes indicated by the black dots; these holes are to be drilled only if the dials specified are used. Also note the distance of the ½-in. holes for the condensers from the bottom of the panel. This dimension is given as 4¼ or 3½ in., the former figure applying if B-T dials are used, and the lesser distance if ordinary dials are to be employed. The other parts required can be of any good standard make.



It is a good plan to remove the coils from the baseboard while wiring the set at other points, mounting them last so as to eliminate the danger of injuring the coils when working around them. All wires connected to G or P-posts, as well as those connected to the stationary plates of the condensers, are high-potential; and should therefore be well spaced and kept away from the other apparatus.

As will be noted in the full-page wiring diagram, the rear trimmer condensers are fastened to the tandem condensers and can be permanently adjusted as follows: The rotor plates on the rear trimmer condenser attached to the right-hand tandem condenser, which is connected to the No. 1 coil, are turned halfway in, while those of the other are turned in fully. The dials on the front panel are then adjusted so that both read 100 when the rotor plates of the tandem condensers are all in and flush with the stationary plates. Connect the 6-volt A-battery to the set;

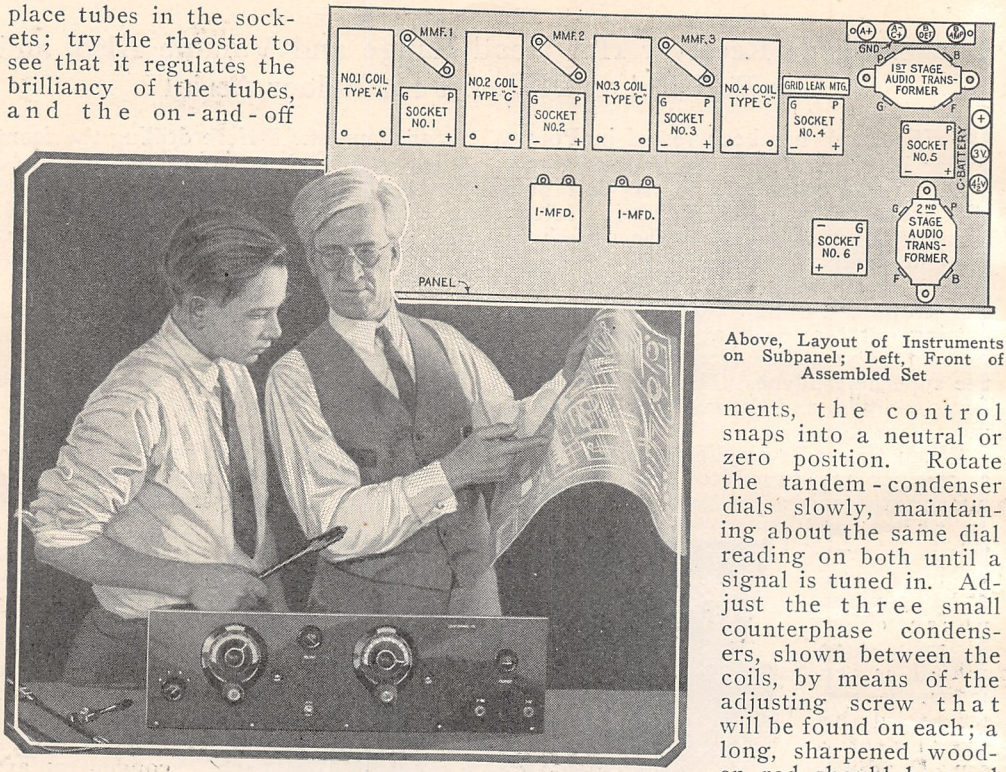
MATERIAL LIST

1	No. 6 counterphase kit (cost $38), consisting of	2	dials $5.00
1	type-TA coil,	2	1-mfd. fixed condensers 2.50
3	type-TC coils,	1	.001-mfd. fixed condenser ..... .50
2	type-LD-17, B-T tandem condensers,	1	.00025-mfd. fixed condenser ..... .35
1	dual resistance (volume control),	1	2-meg. gridleak, with panel-mounting clip. .25
1	4-ohm fixed resistance,	6	standard sockets 4.50
1	set of colored leads.	1	double-circuit jack 1.00
	Other parts (of any good standard make, total cost about $34.26).	1	single-circuit jack ..... .70
1	bakelite or formica panel 3-16 by 7 by 24 in.. $3.36	1	filament switch ..... .50
1	wood baseboard 9¾ by 23½ in..... .25	1	3-ohm rheostat 1.00
1	a.f. transformer, ratio 2.2 to 1..... 5.00	1	inductance switch 1.90
1	a.f. transformer, ratio 4.7 to 1..... 5.75	5	binding posts and mounting strips..... 1.00
		1	4½-volt C-battery ..... .60

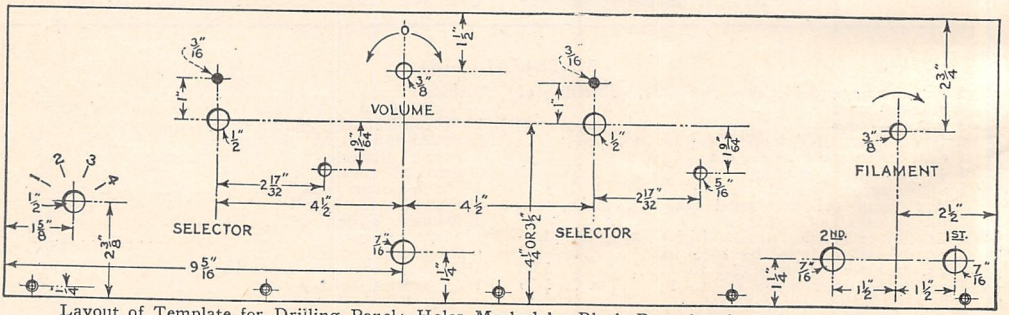
Copyright, 1925, Popular Mechanics Magazine

place tubes in the sockets; try the rheostat to see that it regulates the brilliancy of the tubes, and the on-and-off switch also. To avoid an accident, remove the tubes and disconnect the A-battery. Connect the positive-A of this battery to both of the positive-B binding posts, and connect the A negative of the battery to the B-negative binding post. Insert the tubes; the filaments should not light. If any tube lights this indicates a wrong connection or contact at some part of the B-positive wire or apparatus connected to it. In making this test one tube can be moved from socket to socket.

To adjust the set, place the inductance switch on point 4 and the potentiometer volume control at zero; this is the position when the pointer is straight up or when, halfway between extreme adjustments, the control snaps into a neutral or zero position. Rotate the tandem-condenser dials slowly, maintaining about the same dial reading on both until a signal is tuned in. Adjust the three small counterphase condensers, shown between the coils, by means of the adjusting screw that will be found on each; a long, sharpened wooden rod should be used for turning this screw. Adjust each screw until the pointer at the end of each condenser is halfway down. Now tune in a comparatively weak signal. Reduce the brilliancy of the tubes to the point that gives the best results. Rotate the volume control (potentiometer) to the point giving the loudest clear signal. Plug the loud speaker into the second stage. The volume now should be greatly increased. Adjust the inductance switch to various points from 1 to 4, retuning for each adjustment. Volume should decrease toward 1, but the tuning should be correspondingly sharper, and the greatest volume should be obtained at point 3 or point 4.



Above, Layout of Instruments on Subpanel; Left, Front of Assembled Set



Layout of Template for Drilling Panel; Holes Marked by Black Dots Are for Dials Specified Only

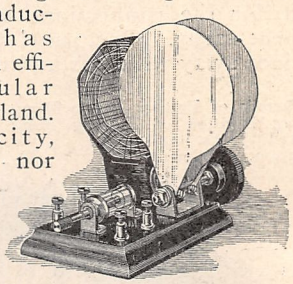
The small counterphase condensers can now be adjusted permanently. Each must be carefully adjusted in turn, beginning with No. 3, which is next to the detector and directly back of tube No. 3. Tune in a strong signal near 40 on the dial. Remove tubes 1 and 2. Tune the signal carefully, using the trimming knobs on the front panel for maximum volume. Set the volume control at the midway or zero point. Rotate the tandem condenser at right back and forth "across the signal," and an oscillation beat or whistle will be heard as the signal is brought in and out of tune, or oscillation may be indicated by a click. When the counterphase condenser No. 3 is properly adjusted, oscillation will not occur, and no beat or whistle will be heard. The proper adjustment is halfway between the point where oscillation stops and the point where it is again heard. Adjust the condenser to this point and leave it permanently at this position. Replace tube No. 2 and adjust the condenser back of tube No. 2 in the same manner, except that the dial on the tandem condenser at the left is rotated across the signal to detect oscillation beat or click. Replace tube No. 1 and adjust the last counterphase condenser No. 1 in the same manner as No. 2. As the point of adjustment is quite sharp on No. 1 and No. 2, it will be necessary to proceed slowly, always making certain that the station is tuned to maximum volume, as the counterphase-condenser adjustment changes the tuning slightly.

When operating a receiving set near one or more powerful stations, it is desirable to shield the receiver in order to obtain maximum selectivity, because the wiring in the set, the battery leads and the tuning apparatus pick up and deliver directly to the detector sufficient energy to produce an audible signal regardless of tuning. This can largely be overcome by lining the inside of the cabinet with aluminum, copper or brass, of about 24-gauge thickness. All parts of the shield should be soldered together in a single unit. All holes should be as small as possible, but large enough to prevent contact with shafts or mounting bushings of any apparatus; also see that the shield does not come in contact with any metal apparatus on the subpanel, except where the apparatus is connected to the same wire or lead as the shield.

Blueprints for this set may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago. Inclose fifteen cents to cover postage and packing. Specify blueprint 105.

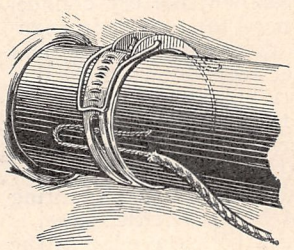
Moving Metal Shields Tune Crystal Set

A crystal set that is tuned by moving metal plates through the magnetic field set up by the inductance coil, has proved to be an efficient and popular receiver in England. Neither capacity, moving coils nor tapped inductances are used in tuning this compact set. A fixed inductance coil of special design is tuned by letting two metal shields pass over the sides of the coil. When the set is working, the tuning coil creates a magnetic field which sets up eddy currents in the metal shields. The latter react and very sharp tuning over a wide wave band can be obtained. The metal shields are not in any way connected with the circuit used, but merely act by induction. For a wavelength outside the range of the coil in use, another coil has to be inserted; this can be done in a moment, as the coils are simply plugged in. The simple operation will appeal to persons who desire to receive broadcasting at close range.



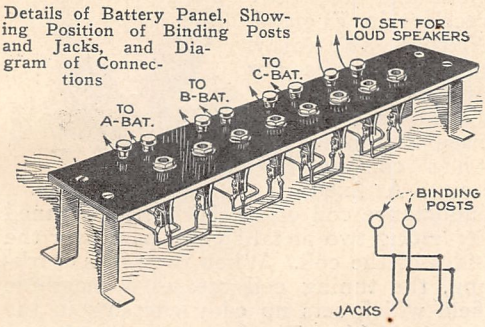
Ground Clamp Requires No Screws

A simple ground clamp that can be fastened without screws is a novelty of interest to radio enthusiasts. As usual, the water pipe is first cleaned with a bit of sandpaper or filed bright at the point where the clamp is to be placed. The ground wire is then bent in the form of a "U," as shown in the illustration, and inserted under the clamp, the spring is placed in the proper notch, and the lever closed, making a quick, positive and direct contact. The importance of having a good ground cannot be overemphasized. Many times the inefficient operation of the set is due to a faulty ground, and with the new clamp, which is easier to install in awkward places than the old type requiring a bolt and setscrew, an efficient ground is assured.



Panel Permits Making Quick Battery Connections

Usually when one is most anxious to test a set, looking for wire and preparing it for the connections wastes time unnecessarily. The panel to be described does away with this and therefore should



Details of Battery Panel, Showing Position of Binding Posts and Jacks, and Diagram of Connections

prove a welcome addition to the experimenter's equipment.

A strip of bakelite, ⅛ by 2½ by 12 in., is drilled for eight open-circuit jacks, as shown in the illustration. These holes are spaced 1 in., center to center, starting 2½ in. from each end. About ½ in. above these holes, directly over jacks Nos. 1, 3, 5 and 7, eight holes are drilled for the binding posts, in pairs. Each set of two jacks and one pair of binding posts are connected in parallel. In this way there will be three connections available for each battery and three separate ones for the horn, or for any other purpose.

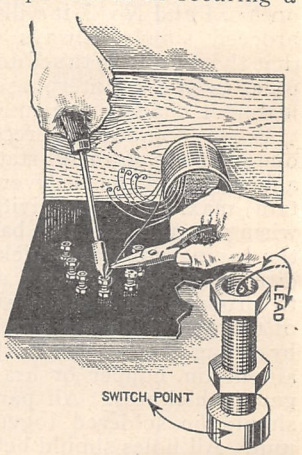
By having two jacks for each battery circuit it is possible to take off two separate pairs of wires, while the binding posts make a permanent battery connection, and can be used for the set in regular use without disturbing that circuit while testing other sets. The panel takes the place of extra binding posts that so often clutter up the work table, and can be mounted under, or flush with the table, as desired, so that all wires will be under the table or workbench. The mounting brackets need not be used if the panel is to be mounted flush with the edge of the table, in which case a piece slightly smaller than the panel may be cut out of the table, and the panel then mounted by means of wood screws. Since there are eight jacks, an equal number of plugs should be provided; connect each plug to a standard 6-ft. telephone switchboard cord, or common lampcord, the free ends of which are connected to the set to be tested. The wire that is connected to the point on the plug should be positive in all circuits; hence it is necessary that this point also make contact with the positive side of all jacks. The free ends of the wires should then be marked for polarity with tags, or painted red for positive and black for negative.—C. Reberger, Roselle Park, N. J.

Good Horn Extension Made from Old Appliance Cord

An ordinary appliance extension cord makes an excellent horn or phone extension for the radio set. The separable plug is pulled apart, and the screw plug is screwed into the socket at the other end of the cord. The free wires are then connected to the output terminals on the set. The phone or horn-cord tips are pushed into the two holes in the plug, where they are tightly held by the springs inside. With this extension, the phones or horn can be taken into an adjoining room without disturbing the set.

Handy Method of Soldering Leads to Switch Points

A handy method of soldering leads to switch points is shown in the illustration. In soldering these leads considerable difficulty is often experienced in securing a good joint without smearing the threads with solder. This can be avoided and a firm connection neatly made by starting a nut on the end of the switch point, just far enough for the threads to catch. The wire is then scraped free of insulation and a small loop is made on the end of the lead. A trace of soldering paste is touched on the surfaces to be joined, and a little solder is dropped in the cup formed by the nut and the end of the switch point. The looped end of the wire is forced into this cup and held in place, while the soldering iron is applied, until the joined surfaces are thoroughly heated. After the iron is removed, the lead is held in position until the solder has set.

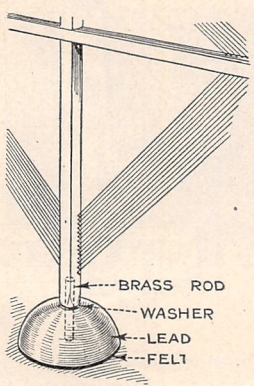


Number of Plates in Variable Condensers Does Not Indicate Capacity

To classify condensers by the number of plates instead of the maximum capacity at which they are rated, is like marking batteries by their size instead of the voltage they are designed for. A 23-plate condenser may have any capacity from zero to infinity, depending on the size of the plates, the thickness of the dielectric, and other factors. This method of specifying condensers by the number of plates rather than the rated capacity originated in the early days of radio, and many manufacturers labeled their condensers in this manner. The public learned to call for a 23-plate condenser when they wanted one with a maximum capacity of .0005 mfd. This rule-of-thumb method will not answer in present-day delicately balanced receivers, and all manufacturers are now marking the rated capacity of their products without regard to the number of plates.

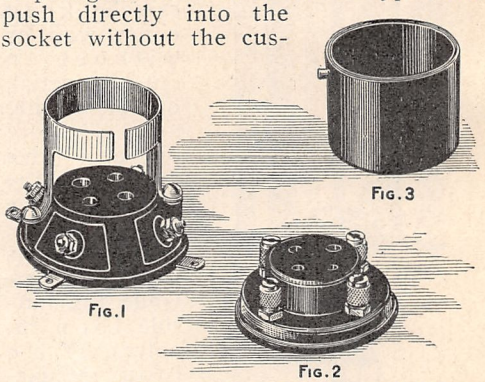
Stable Base for Home-Built Loop

A handy base for the home-built loop can be made of lead formed in the shape shown in the illustration. Making a base which is both good-looking and solid is often a problem, and is usually only partially solved by using a large, flat piece of wood. The objection to a base of this sort is that it is not sufficiently heavy to make the loop stable. The lead base looks good and holds the loop firmly. It is made in a plumbers' ladle by melting enough lead to fill it two-thirds, and after cooling, taking it out and filing all surfaces smooth. Glue a layer of soft felt on the flat side. Drill a hole in the middle of the top, a trifle smaller than the circular brass rod that is used as the connector between the base and the upright of the loop. Drive the rod into the hole, leaving out the required length, which is usually about 3 in. Before setting the loop on the base, a nickelplated washer should be slipped over the rod. This base is naturally quite heavy, which is an advantage rather than a fault. The lead base can be decorated as desired. Gold or silver radiator paint gives a pleasing finish, or ordinary black enamel can be used, which gives a glistening surface matching the radio panel.



Sockets and Adapters for Use with UX and CX-Tubes

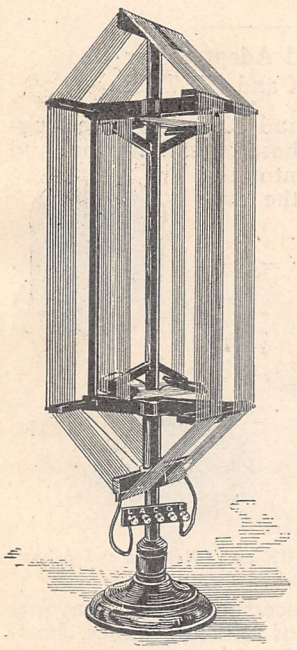
The new UX and CX-tubes have longer prongs than those on earlier types and push directly into the socket without the customary turn as necessary with the bayonet sockets. Most of the new tubes, however, will fit in the old-type sockets with the exception of the new types replacing the UV-199 and C-299, the bases of these tubes having been changed so that the tubes are interchangeable in the new standard sockets. It will be remembered that the plate and grid of the UV-199 and C-299 tubes were placed at opposite corners of the old sockets. The new base arrangement of these tubes is now identical with that of the standard A-type bases. These tubes can be used with the old-type A-sockets, by means of the adapter shown in Fig. 2. This standardizing of bases and sockets makes changing from dry cell to storage battery tubes an easy matter. The socket shown in Fig. 1 is designed to take the old or standard tubes as well as the new types. Fig. 3 shows the new socket in simple form; being small and compact, it takes up very little room on the subpanel. There are several advantages in this type of socket; the tubes goes in easily without risk of breaking the glass tube loose from the base, as often happened when turning the tube in the bayonet-type socket. Good connection between the prongs on the tube to the socket contacts is assured, eliminating a common fault found in the old sockets having spring contacts.



Sockets for the New UX and CX-Tubes and Adapter for Use in Standard A-Sockets

Double Loop Acts as Booster for Outside Aerial

A double loop of novel design has lately made its appearance on the market. It is claimed that this loop greatly increases the range and selectivity of the set, and that it can be used either with or without an outside aerial, on sets having two or more tubes. The feature of the device is the inside loop, which remains stationary while the outside loop revolves. The loop satisfactorily replaces the outside aerial on all types of sets for local stations, it is said, and when used as a booster with an outside aerial, surprising volume on distant stations is obtained. The terminal strip, located near the base, provides for a variety of connections for different circuits.

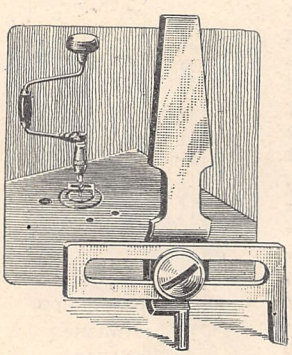


How to Change Sets to Suit Alternating-Current Tubes

In order to use the new a.c. tubes on any standard sets several changes are necessary in the wiring of the circuit. These changes consist in discarding the present filament circuit, and connecting all the negative filament terminals on the sockets to a common busbar. Both filament terminals can be connected to the busbar if desired; this adds strength to the assembly, and the dead post can be connected along with the negative line. This busbar then becomes the cathode lead, and is considered as the filament lead of an ordinary tube. A 4½-volt C-battery is necessary in the grid return of all the tubes, except the detector. The detector grid return is run direct to the cathode lead. The positive terminal of the C-battery is connected to the cathode lead. The negative terminal is connected to the grid return of all the tubes except the detector. The negative B-lead is also connected to the cathode lead. The grid and plate leads are connected as for any ordinary tube. Plate voltages up to 150 volts can be used on the plates of the amplifiers, and from 45 to 90 volts on the plate of the detector. Never connect the 110-volt a.c. circuit to the tubes except through a step-down transformer. When using from one to three tubes the transformer should be connected for 4 volts; for four or five tubes, connect the transformer for 5 volts; over five tubes, connect for 6 volts. Never use higher voltage. The transformer should be not less than 75-watt, otherwise it will heat excessively and burn out. The connections from the transformer secondary to the heater terminals, should be made with not less than No. 14 wire, or flexible stranded wire of similar size. The cathode heaters are all connected in parallel. This is done by running two leads from the transformer secondary to busbars mounted on the upper rear of the front panel. These busbars can be mounted on the panel by means of bakelite blocks, or bakelite binding posts. Flexible leads are soldered to the busbar wires, and connected to the terminals on the tops of the tubes, by means of clips. Keep the a.c. supply transformer at least a foot away from the set, otherwise a hum may be heard through the set. Either one of the busbars, or heater leads, should be grounded on the end farthest from the transformer.

Adjustable Tool Bores Meter Holes

An adjustable tool for cutting large holes in panels for meters, tube sockets, bezels, and other instruments, has lately made its appearance on the market. It is designed to cut mounting holes in either bakelite or hard-rubber panels. The adjustment provides for holes from ⅜ to 3 in. in diameter. On holes ⅜-in. or larger, the sizes commonly used for one-hole mounting instruments, the cutter is claimed to do neater work than a twist drill. The tool fits in an ordinary carpenters' brace.

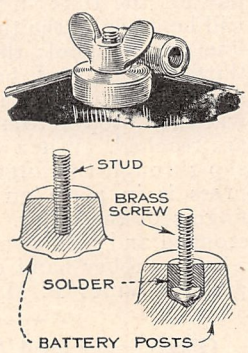


Success with New Hookups Depends on Parts Used

When trying out new circuits, follow the diagrams and specifications carefully. If this is not done, you will probably not get the best results from the set. Usually the designer has carefully selected the parts that work best in that particular hookup, and any deviation will give poor reception. Many parts, such as sockets, rheostats, jacks and fixed condensers, are now standardized so that any good make will do, but this does not apply to other components, such as coils, a.f. and r.f. transformers and specialized parts; these must conform to the needs of the individual circuit. Other parts may be similar in appearance and yet totally unsuited for that particular circuit. For example, in Popular Mechanics superheterodyne, condensers are specified in which the plates are not connected to the shaft. If another condenser is used, having the rotor plates fastened to the shaft, the rotor must be grounded to prevent howls. If this is neglected, as is very apt to occur, no grounding wire being shown in the circuit, the builder will have trouble, and may blame the set, when the fault is in using the wrong condensers.

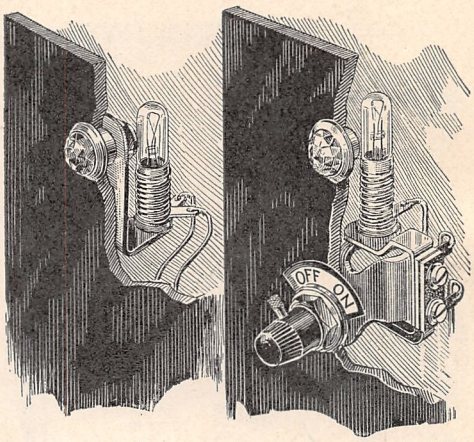
Handy Battery Connector Made of Machine Screw and Wingnut

A brass machine screw and wingnut mounted in the terminals of a 6-volt automobile storage battery, make an ideal connector for this type of battery, which usually comes with tapered cable connections that are unhandy for radio purposes. Two methods are suggested for mounting the machine screw. The lower illustration shows a brass machine screw with a round head; a hole is drilled in the terminal, slightly larger than the head and of a depth to leave an end above the terminal for the wingnut. The hole around the screw is then filled with solder. The illustration above shows a brass machine screw stud mounted in a hole threaded to receive it. Either method is effective and makes a good permanent connector.



Pilot Light on Panel Saves Tubes and Batteries

A pilot light on the panel is an ever-present reminder that the set is in operation, and that tubes and batteries are being needlessly used, if there is no station on the air. Handy lights of this type, which can be operated on the A-battery line, have been marketed lately. They can be used with any type of switch. In the arrangement at the left in the illustration, one hole is drilled in the panel to take the jeweled lens and a locknut at the rear holds the lamp bracket in position. At the right the lamp bracket is shown in combination with an on-and-off switch, and the lens is mounted separately above the switch, which also makes a very neat-looking assembly.



Two Ways of Mounting Pilot Light on Panel, Either with Lens and Lamp as a Unit or Separately

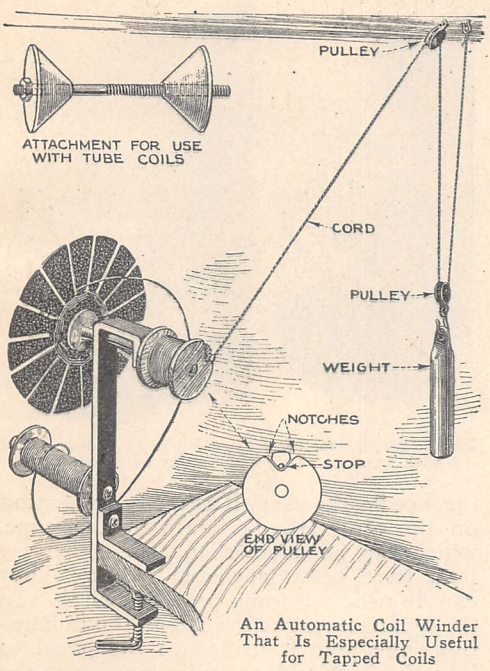
Cleaning Crystals

Crystals that apparently have lost their sensitive spots can be cleaned and restored to their former effectiveness by placing them in a small bottle containing ether. Commercial ether will do for this purpose. Shake the bottle vigorously, and then remove the crystal with a pair of tweezers; do not touch it with the hands. It will quickly dry in the air, and when replaced in the set will often give as good results as when new.

¶On radio sets that are equipped with a potentiometer there is enough leakage across the potentiometer when the set is not in use to cause the A-battery to discharge much more rapidly than usual. Therefore, the A-battery should always be disconnected when the set is not operating.

Semi-Automatic Coil Winder Simplifies Tapping

A coil winder that leaves the hands free for guiding the wire can be built from odds and ends around the workshop.



An Automatic Coil Winder That Is Especially Useful for Tapped Coils

Tubular, spiderweb and diamond-weave coils can be wound on the device, and the number of turns automatically checked.

It is not necessary to make the clamp frame shown; the iron upright can simply be bent at the bottom and screwed to the table, and this will simplify it somewhat, although the clamp fixture is handy. The stock used for the frame should be about ¼ by 1-in. iron or steel. The shaft is made of ⅜-in. round steel, threaded at one end to screw part way into a wall flange and fastened with a pin or set-screw. The flange supports the small wooden blocks used to hold the coil forms; holes are drilled in the center of the blocks for a bolt that screws into the threads in the flange. For the tubular coils a separate attachment is used, made as shown in the detail. A pin to carry the wire spool is riveted near the bottom of the upright.

On the other end of the shaft is fastened a spool-shaped wooden pulley, 1½ in. in diameter. The shaft is revolved by means of a heavy string or chalk line, wound around the spool and then rigged around two pulleys and fastened to the ceiling, as shown. The lower pulley carries a sash weight, which, as it drops, supplies the power to operate the device. The length of the string, of course, depends on the number of turns desired on the coils. Into the outer side of the pulley, about ½ in. below the edge, a pin is driven, and on either side of the pin a notch is cut in the edge of the spool.

Suppose we have to wind 60 turns of wire on a coil in the winder. The weight is down and there are some turns of line on the spool. Lead the line through one of the notches and loop it around the pin, then lead it back through the other notch and wind on 60 turns of the line. This, of course, draws up the weight. When the 60 turns have been wound on, the line may be hooked over the pin again to hold the winder stationary, and the wire started on the coil. Now, when the last loop of the line is thrown off the pin the winder will start to revolve and will keep on until the first loop around the pin is reached, when it will stop.

For tapping, the line is wound on the spool in the same manner, leading the line through the notches and looping it over the pin in the same way as before wherever a tap is to be taken off. It must be remembered, however, that as the string winds off from the outside of the spool and the wire is wound on the coil starting from the inside, the stops for the taps must be arranged in the reverse order when winding the cord on the pulley. For example, if a 60-turn coil is to have taps at the thirteenth and thirty-fifth turns, the first loop made on the pin, when winding on the line, will be the one for the thirty-fifth tap, and the loop will be made at the thirty-fifth turn of the line on the spool; the next loop, for the thirteenth tap, will be made at the forty-seventh turn of the line. The winder will then stop automatically as the loops are reached. When winding, let the wire slip through the fingers of one hand and press it in place on the form with the fingers of the other. The winder can be stopped and held at any point by slipping a wide rubber band over the line on the pulley.—James B. Hays, Boise, Idaho.

Glass Towel Rod Is Good Insulator

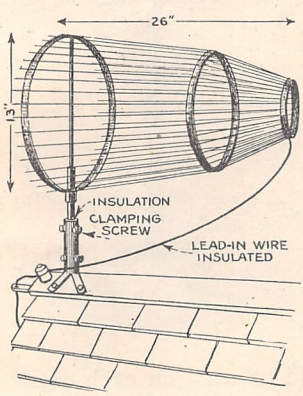
To use a glass towel-rack rod as an aerial insulator, notch the rod at each end with a three-cornered file for fastening the wire. As the rod has a highly polished surface, it makes an ideal insulator, and being usually of heavy glass, it will stand the strain.

Steam Heat Improves Radio Reception by Keeping Set Dry

Moderate dry heat in the house improves the performance of the set, as it reduces the humidity. The effect on the radio set is to drive the dampness out of the coils, and other parts, with the result that the set becomes more sensitive. The receiver of the future may be so designed as to exclude dampness and this would be a great improvement. Artificial heat could even be applied to the set at intervals to obtain the same result. Some of the early instruments were built in separate, sealed boxes with the tubes in a sealed compartment. This idea may be revived. A common light bulb could be mounted in the set, which would radiate enough heat to keep away moisture. In warm, damp climates this trouble is a real problem and these suggestions should be beneficial. When coils, transformers, rheostats and other parts collect moisture, the set is often permanently injured.

Novel Aerial Is Easily Installed

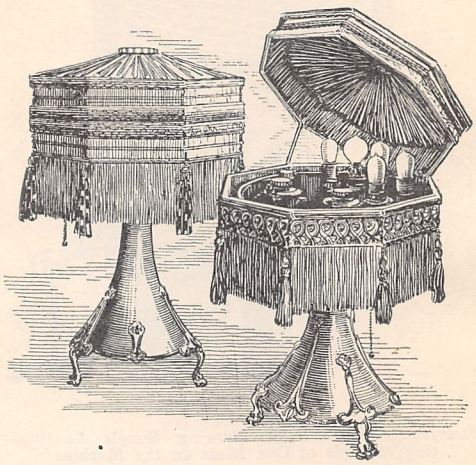
An aerial so shaped that it is easily installed in limited spaces is now available. It is claimed to be more selective than the usual type, limiting interference without reducing volume. It is mounted on the ridgepole with lagscrews in the manner shown in the illustration, and can be turned in the desired direction and locked in place. This feature is of value as the aerial can be placed at right angles to any power line. The lead is taken to an insulator and down over the edge of the roof in the usual way. An aerial of this type makes a neat appearance on the building, eliminating the use of unsightly poles and long wires.



¶LOUD SPEAKER AND AMPLIFIER FOR THE CRYSTAL SET. A novel and effective instrument described in the April, 1925, issue. This number may be obtained from the Circulation Department, price 25 cents.

Radio Set Built like Lamp Has Horn in Base

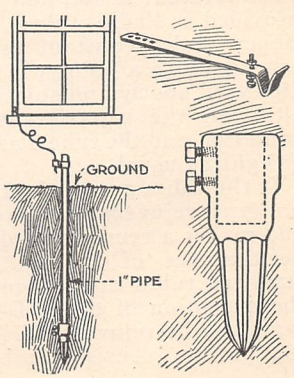
A radio set built in the form of a table lamp with the horn concealed in the base is a recent novelty. The instrument combines in one compact unit a three-tube receiver, a loud speaker and a table lamp. The lamp is built of copper, finished in either gold, silver or bronze to harmonize with various interiors. When the instrument is closed, no one would suspect that a complete three-tube reflex receiver was concealed within.



Upper Part of Lamp Shade Raised, Showing Instrument Panel, and Left, Closed for Use as Lamp

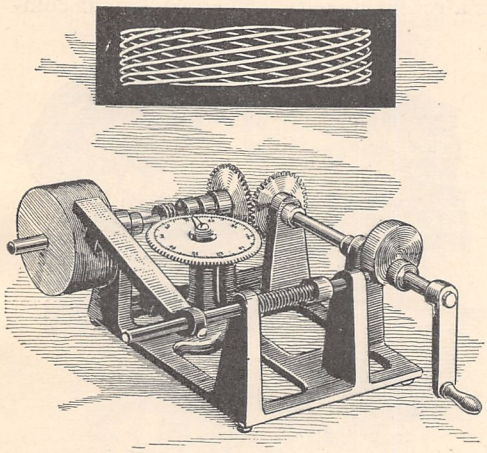
Attachable Peg for Ground Pipe

A peg for the end of the ground pipe to make it easier to drive the pipe into hard soil, has been marketed recently. This simple attachment is screwed to the end of a 6-ft. length of 1-in. pipe which is placed as close to the house as possible. A ground clamp, consisting of a strip of copper, with holes in one end and a heavy bolt in the other, is also available. This is fastened to the top of the pipe along with the ground lead from the set and lightning arrester. The installation is clearly shown in the drawing.



Handy Machine Winds Low-Loss Coils

A handy machine for winding low-loss coils is one of recent novelties on the market. It will wind the popular honeycomb-type coil any width from ½ to 1 in., and the diameter may be arranged to suit by putting various sizes of wooden spools on the winding spindle. The recording dial is provided with a movable pointer for counting the number of turns. The instrument is finished in black enamel and is neat in appearance.



Honeycomb-Coil Winder Showing Simple Construction; Sample of Coil Made on the Machine

Testing of Tubes Is Necessary for DX Reception

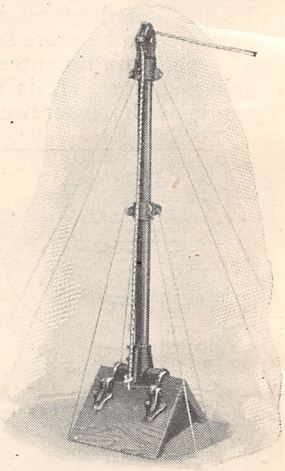
The ideal radio weather at hand, the set should be in the best possible condition to take advantage of distance-getting possibilities; the tubes should be tested, and if found to be of low efficiency, they should be placed in a tube booster and rejuvenated if they are of the type that can be so treated; if not, new tubes should be provided. Radio tubes lose their efficiency under constant use and the loss progresses to a point where the set operates very poorly and sometimes not at all, although the batteries are in first-class condition and the tube filaments apparently light as usual.

If the tubes are of the thoriated-tungsten type, rejuvenation is very satisfactory and makes a remarkable difference in the performance of the set. Most of the standard tubes now in general use, with the exception of the WD-11 and WD-12 types can be rejuvenated. This reactivating process consists in boiling thorium atoms out of the interior of the tungsten filament so that they form a new layer on the surface, making possible greater activity within the tube. This is done by operating the filament for a very short time at a specified high voltage, followed by a lower voltage. There are a number of inexpensive tube boosters available for doing this at home, the 110-volt 60-cycle house-lighting current being suitable for the work.

Approximately the same results can be obtained by operating the tube filaments in the set with the A-battery in the usual manner, the B-battery being disconnected from the set. This operation should continue for several hours, the length of time depending on the condition of the tubes.

Aerial Mast Clamps to Ridgepole

Metal aerial-mast fixtures for fastening the mast to the ridgepole of the house are now available. The fittings are adjustable to fit various types of roofs and roof pitches, and consist of a cap with a sheave pulley and lugs for guy wires, a collar with lugs and a universal masthead with loop for attaching the aerial cable. The pipe does not require threads at either end and can be purchased from the local plumber in the length required. One-inch pipe is used for the mast. By adding lengths of pipe the aerial may be made of any height, but in that case, one guy-wire collar should be used on each extra length of pipe to brace it sufficiently.



Colored Wires Identify Leads

If battery leads are not marked for identification, there is a chance of placing heavy voltage on the filament terminals. This can be avoided by using insulated wire with various-colored braided covering. Stranded wire of this type can be obtained in red, black, white, yellow, green and brown, and with different-colored tracer threads.

Getting Rid of the Squeals

Howls, Hums and Reradiation Are Usually Easy to Prevent with a Little Time and Effort

GETTING rid of squeals, howls and hums, and preventing reradiation, are topics of everyday conversation among radio fans. All are interested because these annoying ailments are so common, caused by induction from power lines, interference from regenerative receiving sets or improper tuning.

Power-line hum can usually be minimized or eliminated by running the aerial at right angles to the lines causing it, as shown in Fig. 1. Drumming noises from power lines often can be located in a leaky transformer in the neighborhood. In such cases the power company will usually co-operate to eliminate this trouble by repairing the transformer.

Squeals inherent in the set due to its design can be reduced and often eliminated by properly tuning it. One-tube regenerative circuits of the kind shown in Fig. 3 are of this type. The reradiation is due to its conductive feedback into the aerial. However, this is not the only type of reradiating set that causes howls that interfere with the pleasure of other listeners within a range of several miles; all types of regenerative receivers are troublesome in this respect. Even the superheterodyne receiver, although it does not come under the regenerative heading, is a bad offender when used on an outside aerial.

In order to find out whether your set is causing such trouble, make arrangements with your neighbor to listen in to the same station at the same time. When tuning in your set to that wavelength turn

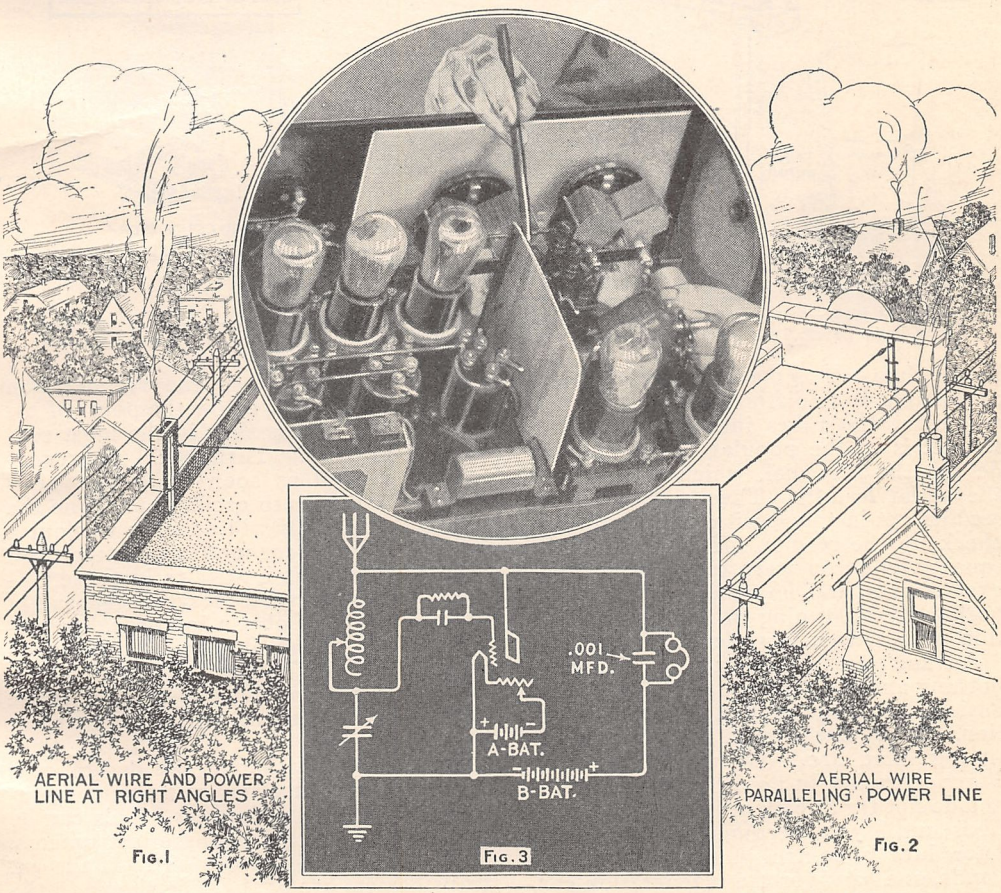


FIG. 1

FIG. 3

FIG. 2

Above, Shielding Prevents Intercoupling between Transformers and Tubes; Below, Single-Circuit Regenerative Receiver, Which Acts as a Miniature Transmitting Station

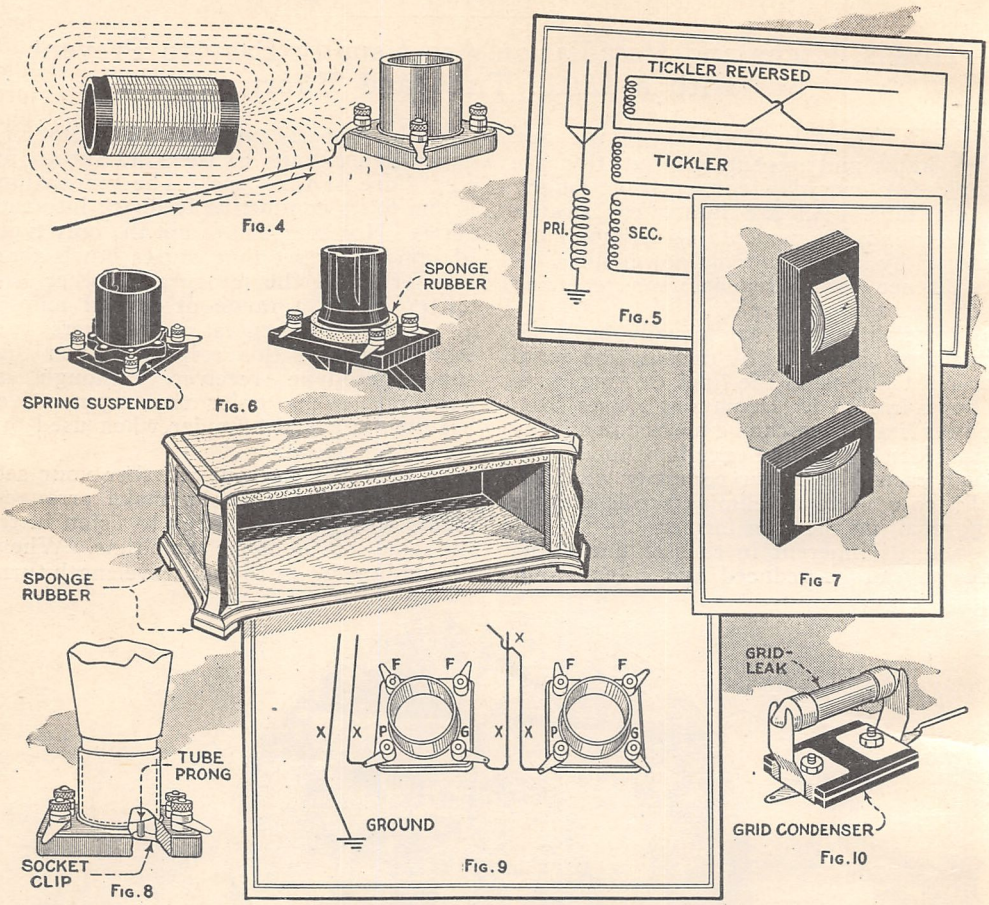


Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10

Squeals and Howls in Radio Reception Are Often Caused by Faulty Design and Arrangement of the Instruments, Microphonic Tubes, Poor Contacts, Wrong Gridleaks and Other Errors Which Anyone Can Correct

up the rheostats to make the signal as loud as possible up to distortion. This will usually drive the tubes into oscillation. If the set is of the popular tuned r.f. type, detune the first dial, which is closest to the aerial lead-in. Then switch off the set and get in touch with the neighbor to check up the results. If he has heard a squeal while you were carrying on these experiments, and no others in the neighborhood were tuning in to the same station in this way, your set is at fault.

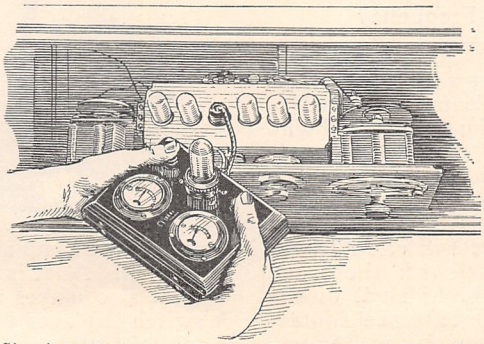
Advancing the rheostats too far gains nothing and shortens the life of the tubes, besides spoiling your neighbor's reception. There are several rules for proper tuning that are well worth knowing. Practice tuning in powerful stations first, and do not try to pick up weak distant stations until you become an expert and know how to control your set. Use both hands, one hand for the regeneration control, such as a potentiometer or tickler if the set has one, and the other hand for the tuning control. Keep the regeneration control always just below the point of oscillation; the set is then in the most sensitive condition. Turn back the regenerative control as soon as the set accidentally breaks into oscillation. Tune the set so that signals will come in without a whistle. The regeneration control can then be turned up a little to increase volume. Do not try to force regeneration in an attempt to obtain loud-speaker volume from a set not designed for this purpose. Do not force regeneration in an attempt to hear stations beyond the range of the set; be content with those that can be really heard.

Squeals originating in the design of a receiving set can often be traced to coupling tubes or transformers. This can be prevented by shielding these instruments, as shown in the photo insert. If the a.f. transformers are of the type shown in the upper part of Fig. 7, they should be turned at right angles to each other, to prevent

intercoupling of their fields. The lower transformer is of the vertical-core type, and turning it at right angles to another of the same type, has practically no effect, as this does not put their fields in a right-angle relation. Transformers of this type must be spaced a reasonable distance apart, but do not have to be turned. Transformers of the r.f. type shown in Fig. 4 should be placed in the set with care around coils carrying high-frequency currents, destroying the tone. These transformers should be mounted in such a position that the lines of force will cut each other as little as possible. Even with this precaution, the field from the coil sprays near-by wires and pieces of apparatus, inducing current in them that often causes broad tuning and distortion with its usual chorus of howls and squeals. A new doughnut-shaped coil, called a toroid coil, which is so designed that the field is confined to the coil regardless of the position in which it is placed in relation to other instruments and wiring, will remedy much of this trouble.

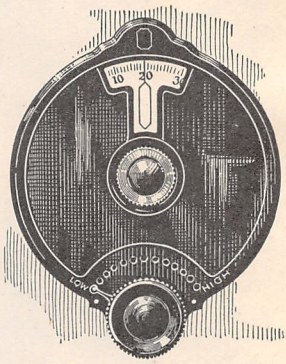
Receiving sets of the three-circuit type often give poor results if the tickler coil is reversed as shown in Fig. 5, as this "bucks" the current in the secondary coil, thus neutralizing the grid circuit. Horn noises are often caused by vibration, small tubes of the dry-cell type being especially apt to cause this trouble. To prevent it, use sponge-rubber pads under the corners of the cabinet, or use shock-absorber sockets of the type shown in Fig. 6.

A common source of trouble is poor contact of the tube prongs with the socket clips. Pull up the prongs of the socket with a stout string, replace the tube and reinsert the socket. A sectional view of the socket is shown in Fig. 8. Plate and ground leads running parallel as shown in Fig. 9, and plate leads touching grid leads, or running close to them, will cause howls. Keep such leads separated as far as possible, and when necessary to cross them, run the wires at right angles. Fig. 10 shows the common type of grid condenser and leak; trouble can often be traced to a defective condenser. It may have been ruined by excessive heat when soldering, and as a precaution against this, soldering lugs should always be fastened to such condensers by means of two short brass machine screws, and the wire should be soldered to the end of the lug before the lug is screwed to the condenser. The gridleak may have too much or too little resistance; try different resistances until one is found that gives the best results.



Showing Method of Testing Tubes under Operating Conditions with Combination Tester and Trouble Finder

Vernier Dial Has Device for Changing Ratio



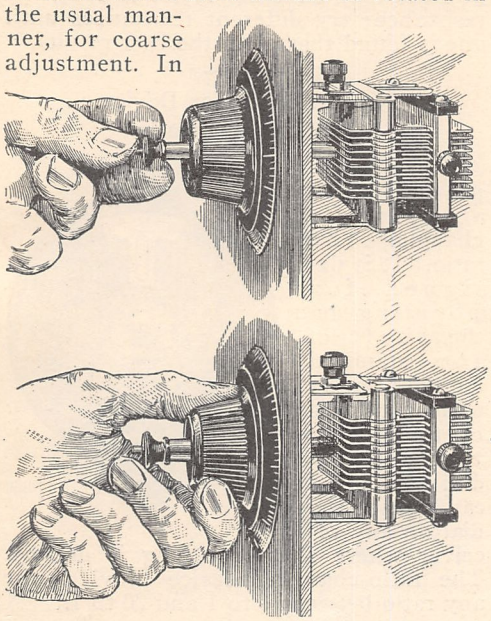
A new dial is provided with a device for changing the ratio. It is designed for mounting on the shaft of any standard condenser without the use of tools other than a screwdriver, and can replace the dial on any receiver where sharper tuning is desired. The ratio-changing device provides for any ratio between 6 to 1 and 20 to 1.

Combination Tube Tester and Trouble Shooter

An instrument which not only tests tubes under operating conditions but can be used to locate trouble in the set has lately made its appearance on the market. The illustration shows the method of reading the plate current of the tubes in milliamperes. The instrument is also provided with a combination plate and filament voltmeter for testing the A and B-battery voltage. In addition, it can be used to locate defective tube sockets, open circuits in transformers, poorly soldered joints in the circuit and defective contacts in the jacks. A tube tester of this type is really necessary to get the best results from any multi-tube set; one poor tube may spoil the reception in an otherwise perfect instrument and a check on the A and B-batteries is desirable at all times.

Push-Pull Adjustment Features Variable Condenser

In a new variable condenser the movable plates are pushed or pulled by means of an insulated stem instead of rotated in the usual manner, for coarse adjustment. In addition to this, very fine adjustment can be obtained in the usual way, by means of a dial. A micrometer screw coupled with the mechanism permits a movement of only .0001 in. Graduations on the stem are numbered 1 to 10 and on the dial from 0 to 100. The claim is made that body capacity and losses are reduced to a minimum. The movable plates are connected electrically to the frame and are grounded, and the fixed plates are 2 in. from the inside face of the panel.



Above, Moving the Plates with the Stem for Coarse Tuning; Below, Fine Tuning with Dial

Testing Audio-Frequency Transformers

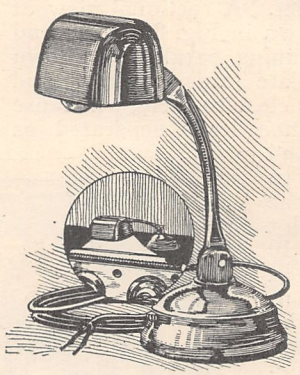
A simple way to test a.f. transformers that are suspected of being grounded to the shell or frame, is of interest to all who have encountered such trouble. Connect one tip of a pair of headphones to the 16½-volt terminal of a 22½-volt B-battery unit, and the 22½-volt terminal to a short length of insulated wire. Without touching the bare wire with the hand, hold it against the case or shell of the transformer, being sure to make contact with the bare metal. Touch the free terminal of the headphones to each transformer terminal on the side of the transformer to which the wire is connected. Repeat this test on the other side of the transformer. A distinct click indicates that the terminal to which the connection is made is grounded to the frame. A similar test with the battery and phones can be used to locate an open circuit in the transformer; if there is no click in the phones when the connection is made across the coil, the circuit is open.

Good Ground Increases Efficiency

The radio set's efficiency can be increased from 25 to 100 per cent by the proper installation of a suitable ground. Many enthusiasts take great pains to erect a good aerial, then make the mistake of twisting the ground wire around a steam-radiator valve or gas pipe, and wonder why the results are not what they should be. A cold-water pipe makes a good ground under most conditions, but not always. The actual ground connection begins where the lead wire enters it. This means that if the water pipe is on the third story, the lead to the ground would be too long to be efficient. In a case of this kind it would be better to place a counterpoise under the aerial. When connecting the ground lead to a water pipe, always use a ground clamp.

Portable Lamp for Radio Receiver Is Run by A-Battery

A small portable radio lamp, which is connected directly to the radio A-battery, is now available. It is designed along the lines of a standard desk lamp, and supplies just the right amount of illumination for easy dial adjustment when placed on the cabinet, as shown in the insert. The eyes are shielded from the direct rays, and the lamp adds to the appearance of the set. As it is provided with a long cord, it also makes a good trouble finder. A switch is placed in the base. The lamp is a 6-volt automobile bulb and thus draws very little current from the A-battery.



A Radio Set for Fifty Cents

Method of Tuning Is Unusual, but Simple, and Principal Parts Are Made from Scrap

By WILL H. BATES

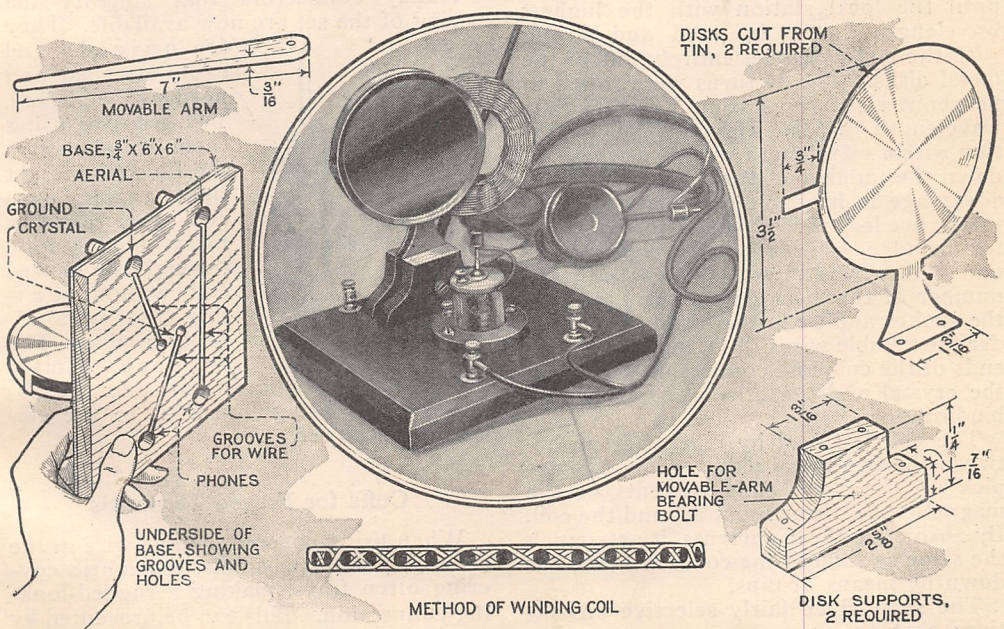
THE crystal set, to be described, which can be built at a cost of about 50 cents, will give good volume on local stations, and will be found an interesting experiment because of the method of tuning.

The only parts you need to buy are the crystal and holder, 4 binding posts, a small spool of No. 22 d.c.c. wire and about 8 in. of a flexible wire. They can all be found at the 5 and 10-cent store.

A 6 by 6-in. block of wood forms the base, which can be beveled on the edges, sandpapered and stained. See that it is thoroughly dried in a slow oven. On the underside countersink four holes with a ½-in. bit, about halfway through the wood. Then drill holes through to the top to take the binding posts. In the center of the board, drill two holes, about 1 in. apart, to carry wires up to the crystal. Now cut grooves in the underside of the board, deep enough to receive the wires (covered with spaghetti) as shown in the detail drawing, and run a wire from the ground post to one side of the crystal; from one phone post to the other side of the crystal; and from the aerial post to the other phone post. When this wiring has been done, turn the board over and mount the crystal holder near the center, then connect the wires coming up through the board to the binding posts of the holder.

Two small blocks, cut out in the shape shown, are mounted on top of the base just back of the crystal. The movable arm between them is held in place with a machine screw, and is tightened with a nut on the back to give the proper tension. This arm is made out of a thin piece of wood, about 3/16 in. thick, flat on the end drilled for the screw, and rounded out with a knife in a tapered effect, so that it may be pushed through the openings in the low-loss spiderweb coil.

The two metal disks can be cut out of a sheet of tin or brass, or even from the lids of tin cans, as was done in the set illustrated. One should have a strip ¼ by ¾ in. projecting at the side, as shown, which is used to bend around the edge of the other and hold the two together. They should be just a trifle larger than the coil, or about 3½ in. in diameter. Mount them on the two little blocks, flush with the inside edges, so that they fit close to the coil when it is moved up between them.

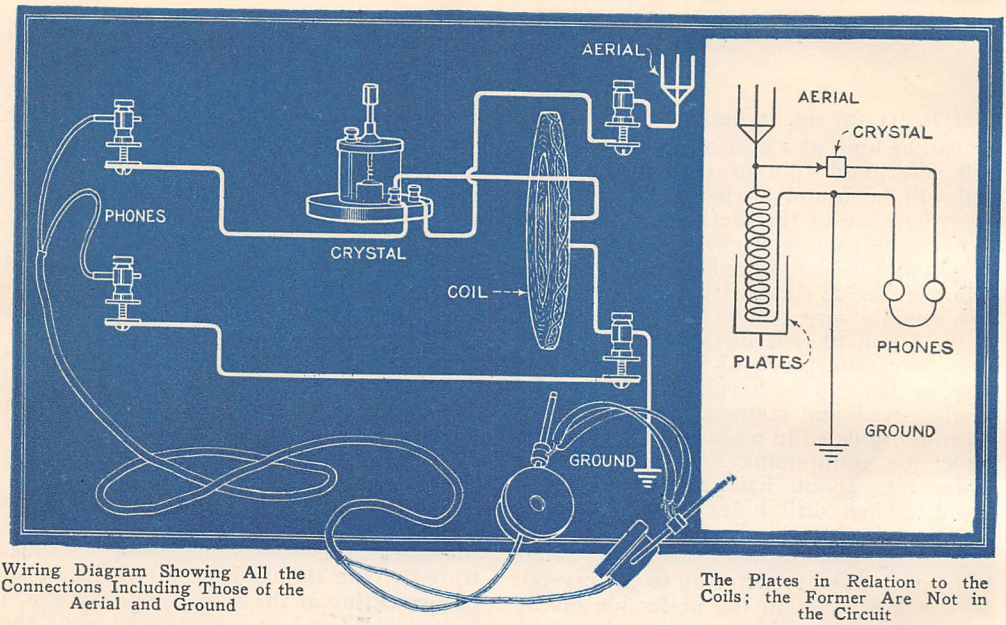


Construction Details of the Crystal Receiver; the Edge of the Coil Is Shown to Illustrate How the Winding Appears on the Finished Coil; Insert, the Finished Set, with Headphones Connected

The coil is wound on a spiderweb form with 17 or 19 spokes, which can be removed afterward. Use the "over two and under two" method in winding. About 44 turns will be needed. A few more turns might be put on so that one can experiment by connecting the coil in the circuit, and take off one or two turns at a time until the local station with the highest wavelength comes in good and strong with the coil extended entirely out of the metal disks. The 44 turns were found to be about right for station KYW with a wavelength of 535. If you have no station with a wavelength as high as that, cut down the number of turns, as there is no advantage in having more turns than actually needed, unless you want to "fish" for distance, which is usually very uncertain with a crystal set. When the right number of turns has been found, remove the spokes and tie in the usual way. Solder the flexible wires (4-in. lengths) to the ends of the coil, and connect one end with the crystal and the other with the aerial binding post.

The coil is tuned by moving it up between the two metal plates. These plates pick up the stray eddy currents or the magnetic field thrown out around the coil. By absorbing these currents, it acts much the same as though the coil was being cut down by means of taps.

The set will be fairly selective on stations that are several miles away. You will not be able to tune out a powerful station if it is within a few blocks of you, but even so, it will be found a very interesting experiment in one phase of the mysteries of radio.

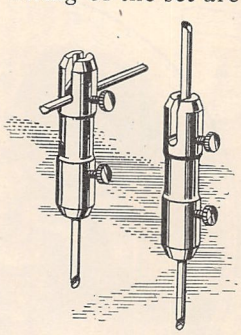


Wiring Diagram Showing All the Connections Including Those of the Aerial and Ground

The Plates in Relation to the Coils; the Former Are Not in the Circuit

Handy Connectors Make Wiring Easy

Handy connectors that simplify the wiring of the set are now available. They are quickly and easily attached, and need no soldering. Two ways of using them are shown in the illustration. At right angles, one end connection may be made through the slotted end without cutting the wire already in place. The setscrews make good electrical connections, and the absence of soldering flux adds to the efficiency of the set.



Cuffs for Frayed Terminals

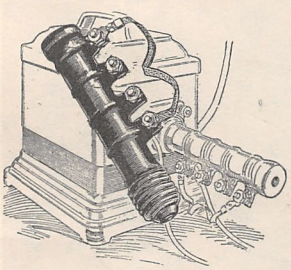
When using covered flexible wire in the set or on loop terminals, the fabric covering often frays, making a ragged-looking connection. This can be prevented by placing a short cuff of spaghetti over the end of the wire before soldering the joint.

Wire Fence Is Good Substitute for Ground

Wire fences are very good substitutes for grounds, especially in dry, sandy countries, where damp ground connections are not available. This is a handy thing for the tourist and camper to know, as it is a very simple matter to fasten the ground wire to a near-by wire fence and obtain good results, without the necessity of driving a rod into the ground, which would often be ineffective. The wire fence also acts as a counterpoise, forming a condenser of which the ground is one plate and the fence the other. Wire fences, in fact, often make better grounds than water pipes. Farmers who have difficulty in locating good grounds will also find springs and streams useful. A bare wire strung along the bed of the stream, will often be very effective.

Resistance Unit Adapts Charger for Wet B-Batteries

A tapped resistance unit, designed for use with the recent models of a.c. battery chargers of the tungar type, so that storage B-batteries can be charged at their proper rate, has lately appeared on the market. In addition to the rectifying tube in these chargers, a standard lamp socket is provided, into which the resistance can be screwed to reduce the charging rate to suit the size of the battery being charged. When radio B-batteries are to be charged, the rate must be reduced for the small battery plates. To this end, a resistor is needed, and a separate terminal is provided on the charger for the higher voltage required.

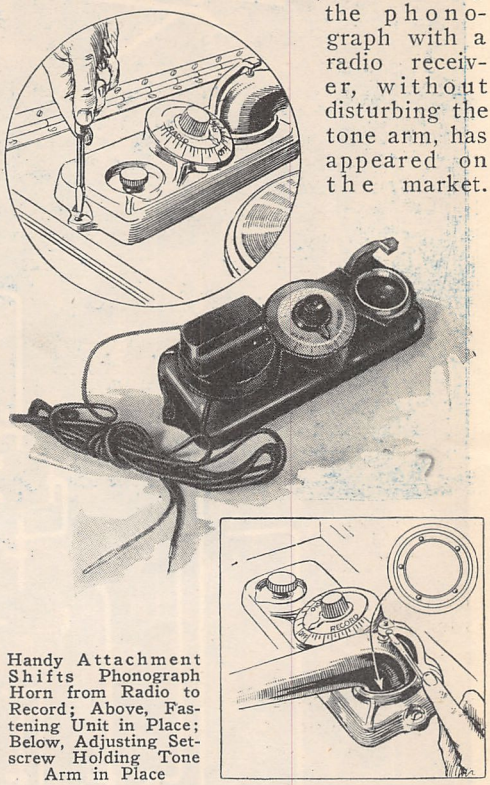


Variable Resistance Controls Horn Volume

A variable resistance of the carbon-pile type can be used to control the horn volume without disturbing the balance of the circuit. This unit may be connected across the output terminals; is mounted on the panel at a convenient point or placed on a long flexible lead, so that the volume of the set can be controlled at a distance, if desired.

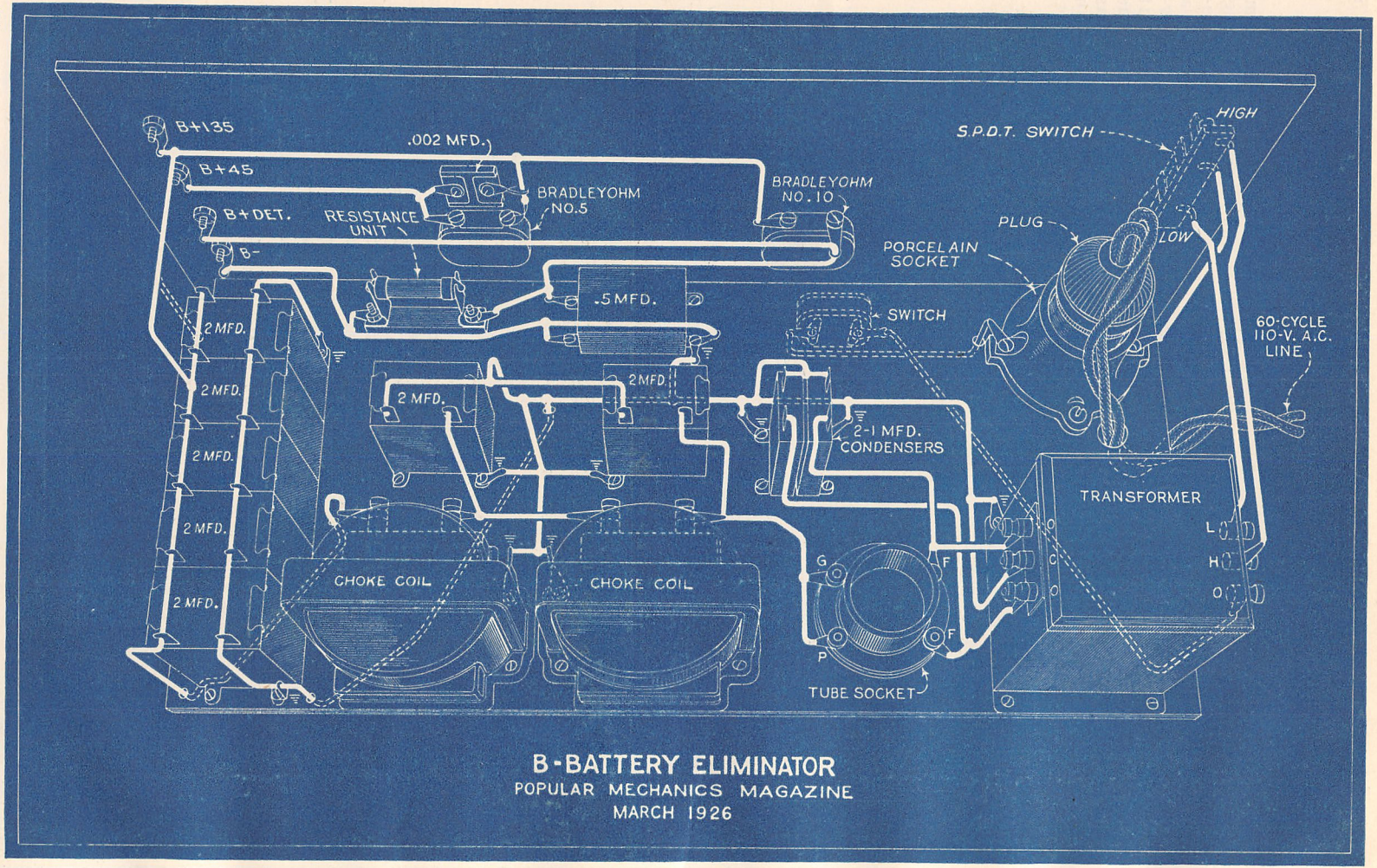
Device for Shifting Horn from Radio to Record

A new device for shifting the horn from the radio set to the record, in combining the phonograph with a radio receiver, without disturbing the tone arm, has appeared on the market.



Handy Attachment Shifts Phonograph Horn from Radio to Record; Above, Fastening Unit in Place; Below, Adjusting Setscrew Holding Tone Arm in Place

This handy instrument can be fastened to any phonograph with the aid of a screwdriver in a very few minutes. It consists of a microphone and cord for connecting to the radio set, a dial, marked radio on one side and record on the other, and a mounting base for the tone arm. The tone arm is removed from the phonograph by taking out the three screws that hold it; it is then separated from its base by loosening the little screw at the top of the bracket, and the device is then mounted on the phonograph over the opening where the tone-arm base was before, in the manner shown in the upper illustration. The mounting receptacle is a reproduction of the tone-arm base. The ring containing the five bearings is placed under the tone arm which is then placed in position and the pin and setscrew adjusted as shown in the lower illustration. Shifting the dial now changes the phonograph horn over from the record to the radio set and the usual bothersome disconnecting of the microphone unit is no longer required.



B-BATTERY ELIMINATOR

POPULAR MECHANICS MAGAZINE
MARCH 1926

How to Build Your Own B-Eliminator

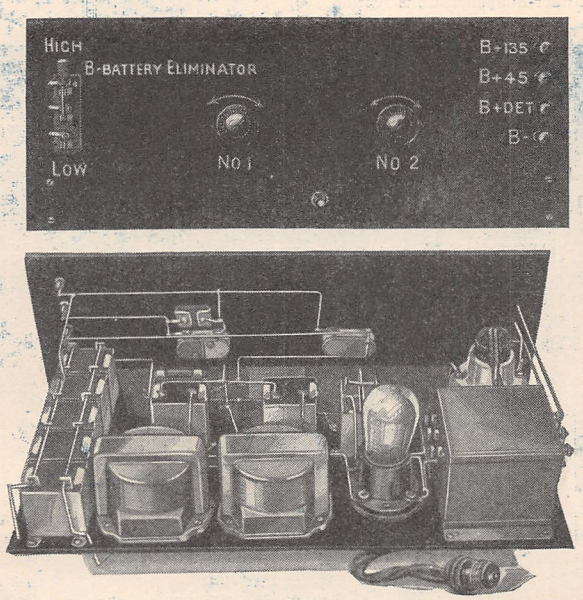
By F. L. BRITTIN

CONTRARY to general opinion a B-eliminator cannot be built up from the usual three-element tube, a spark coil and a few common condensers. Every part must be specially built, the condensers must be able to carry the load, and at the same time small enough to permit compact assembly. Such parts being available now, the radio fan can build his own B-eliminator so as to deliver up to 180 volts if desired. The instrument to be described works smoothly without the slightest hum when properly constructed, and B-battery troubles are permanently eliminated. Full-strength B-voltage is always on hand, resulting in maximum efficiency of the set at all times. The source of supply is the 110-volt, sixty-cycle a.c. house-lighting current, and the eliminator can be plugged into any convenient wall socket.

We have shown two types of the eliminator to permit our readers to choose the one best suited for their needs. The circuit of both is practically the same. The arrangement shown in the large blueprint was built up in our laboratory for sets of the superheterodyne type requiring a variety of voltages. A standard-size bakelite panel is used, so that the device can be placed in a cabinet if desired. This panel is 3/16 by 7 by 18 in. The subpanel is 3/16 by 9 by 17 in., and is mounted on brackets, 2 in. above the base of the cabinet, in the manner shown in the illustration. Note that the push-pull switch is the only instrument mounted below the subpanel. The photo of the front panel and the completely assembled instrument will give the reader a good idea of the neat and compact arrangement. The various voltages indicated on the front panel are especially suitable for the 1926 model of Popular Mechanics superheterodyne. Control No. 1 is for the first detector and oscillator plate voltages; No. 2 controls the intermediate voltages, and the maximum voltage is taken from the upper binding post. This voltage can be either high or low, depending on the way the small single-pole, double-throw switch, shown on the left side of the panel, is thrown. The position of the instruments on the front panel can be changed to suit the builder, but it is necessary that the instruments on the subpanel are arranged in the manner shown for best results, as it is essential to keep the input and output separated as far as possible.

The fixed condensers may be of any good type, but it is very important that they be of the highest grade, and should be tested to 800 volts at least. The five 2-mfd. fixed condensers placed across the output make for good quality, permitting the low notes to come through the set. The porcelain socket is of the common variety. Twisted lampcord of the length required is connected with a plug at each end and run through a hole in the subpanel directly back of the socket, then taken out at the rear of the instrument. In connecting the B-eliminator to the set, either use a cable or bind all the wires closely together in cable form.

By following these instructions the eliminator can be placed as near or as far from the set as desired. When throwing the S.P.D.T. switch from low to high voltage, it will be necessary to adjust the No. 1 detector voltage. A C-battery is always advised with any radio set using audio amplification. The table at the end of this article gives the values to use with this eliminator and different types and



Rear View of Finished Instrument, Showing Compact Assembly; Above, Details of Front Panel with Controls Plainly Marked

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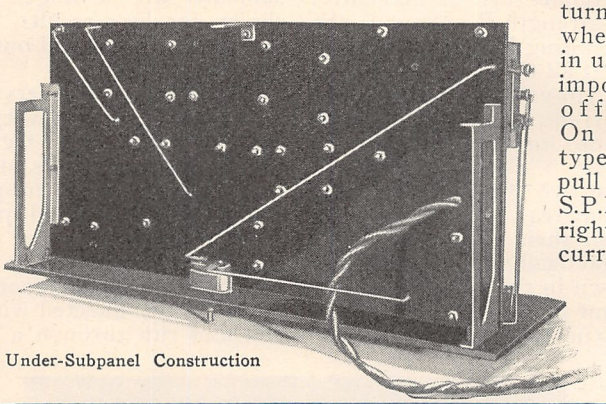
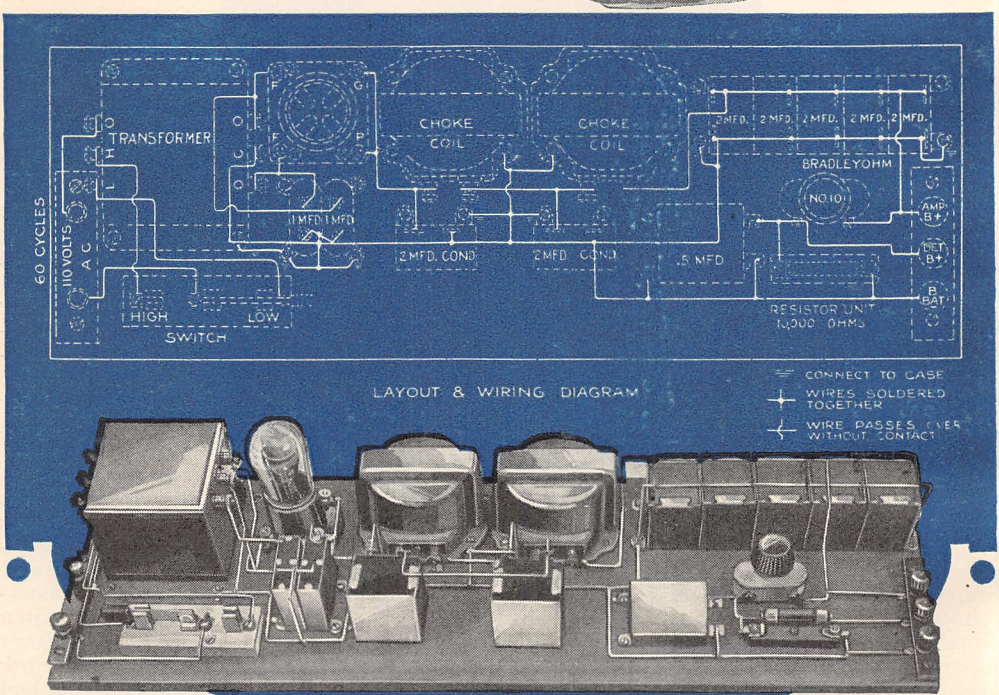
combinations of vacuum tubes. The material list specifies the types of materials used in the models tested out in our laboratory.

The breadboard arrangement of the eliminator is for those who wish a simpler and cheaper type, suitable for sets requiring but three B-battery terminals, namely B—, Det. B and Amp. B. The board is ½ by 7 by 23 in. in dimensions and the same instruments are used with the exception of the No. 5 Bradleyohm and the .002-mfd. fixed condenser. The S.P.D.T. switch may be of the cheap porcelain type. The binding posts are mounted on strips of bakelite raised ½ in. at each end of the board. The wiring diagram is given above the photo of the completed instrument. This breadboard assembly can, of course, be arranged for the additional 45-volt terminal if desired, but the panel and subpanel design takes up less room and improves the appearance. In both wiring diagrams the points to be grounded are marked with the usual ground symbol. These are not external grounds, however, but circuit grounds to the metal shells of the instruments, and are necessary to obtain good results.

In operating a device of this kind, it is always well to remember that it is connected to the power line, and like any other device operated by the house-lighting current, it should be turned off before handling any part except the insulated controls on the front panel. The push-pull switch on the front panel is used for this purpose. Do not forget to turn this switch off when the set is not in use; this is just as important as turning off the A-battery. On the breadboard type of eliminator, pull the blade of the S.P.D.T. switch upright to shut off the current. The eliminators use very little house current, and when correctly built, with the mate-



Under-Subpanel Construction



Breadboard - Type of Assembly

Simplified Wiring Diagram Above

rials specified, give excellent results. There is no upkeep expense, as the tube and other parts are practically indestructible.

A large blueprint of both circuits can be obtained from the Radio department of Popular Mechanics Magazine, 200 E. Ontario St., Chicago, for 15 cents. Specify blueprint No. 106.

C-BATTERY VOLTAGE TABLE

TYPE OF TUBE	NUMBER OF TUBES IN SET															
	WITH LOW-VOLTAGE TAP								WITH HIGH-VOLTAGE TAP							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
UV-201A; C-301A	10.5	9	7.5	6	4.5	3	1.5	1.5			19	16.5	15	12	10.5	9
UV-199 OR C-299	18	15	13.5	12	10.5	7.5	6	4.5								21
201-A PLUS / 301-A " } ONE UX OR CX-112		7.5	6	6	4.5	3	1.5	1.5		19	16.5	15	13.5	12	10.5	9
UV-199 / C-299 } PLUS ONE UX OR CX-220		13.5	12	10.5	7.5	6	6	4.5							21	18
CX-112 OR UX-112	9	7.5	6	4.5	3	1.5			19	16.5	13.5	12	12	9	7.5	6
CX-120 OR UX-120	15	12	7.5	6	3	1.5						21	15	12	10.5	7.5

MATERIAL LIST

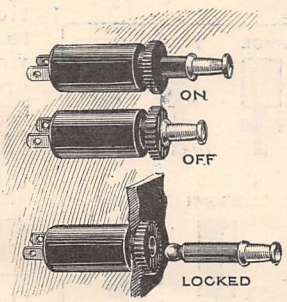
1 bakelite panel, 3-16 by 7 by 18 in.
1 bakelite subpanel, 3-16 by 9 by 17 in.
2 Benjamin subpanel brackets.
1 socket, common porcelain type.
2 fixture plugs of the pull-apart type.
6 ft. lampcord.
1 Cutler-Hammer push-pull switch.
1 Acme B-4 transformer.
2 Acme B-2 choke coils.
1 Raytheon tube.
1 standard tube socket.
7 Tobe-Deutschmann fixed condensers, 2 mfd.
2 Tobe-Deutschmann fixed condensers, 1 mfd.
1 Tobe-Deutschmann fixed condenser, .5 mfd.
1 Bradleyohm variable resistor No. 10.
1 Bradleyohm variable resistor No. 5.
1 Bradley fixed resistor unit, 8,000-10,000 ohm.
1 fixed condenser, .002 mfd., any good make.
1 Marco S.P.D.T. switch.
4 binding posts with engraved tops.
39 round-head, brass machine screws, 6-32, ½ in. long.
2 round-head, brass machine screws, 6-32, 1 in.
4 doz. soldering lugs.
2 two-foot lengths No. 14 round, tinned-copper bus-bar wire.

New Jack Controls both Amplifier Stages

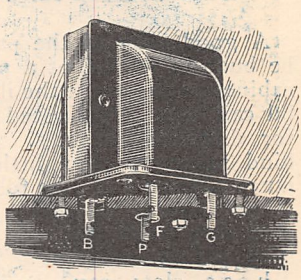
A two-stage jack which has been marketed recently, is novel in that it may be used in a receiving set for controlling either one or two stages. By inserting a plug into the jack until the first notch is encountered, one stage of amplification may be cut into the circuit, and by pushing the plug all the way in, both stages are automatically connected in it. This eliminates an extra jack and the volume is controlled by a single operation.

Switch Locks Set and Prevents Unauthorized Tampering

The radio-battery switch shown in the drawing assures the operator that no one will tamper with the set during his absence. This will prove a boon where children are apt to turn on the radio set and leave the tubes burning after they have finished listening in. The nickel shaft of the switch shuts off the battery current when it is pushed all the way in. When the shaft is pulled halfway out, the current is turned on. The shaft can be pulled all the way out of the switch and carried in the pocket of the owner, in the same manner as he would use his auto key. The A-battery is then shut off and the set cannot be operated until the "key" or shaft is replaced.

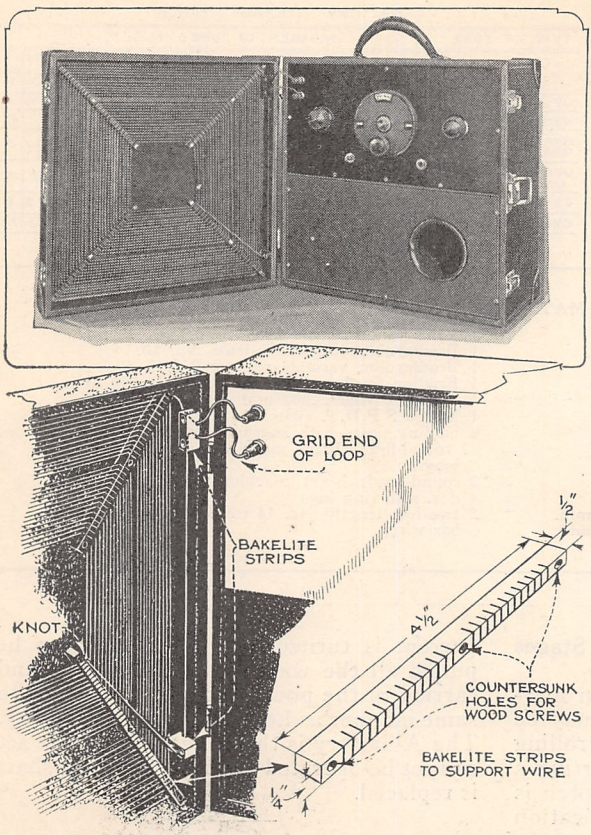


Audio-Frequency Transformer Simplifies Wiring



An audio-frequency transformer furnished with leads coming out of the base is intended to simplify the wiring of sets mounted on subpanels. Obviously, this method of bringing out the leads provides neater assembly, shorter leads, and makes the set look like a factory-made job. Instead of the usual binding posts, soldering lugs are provided.

¶German telegraph authorities are making preparations to establish radio-telephonic communication between liners at sea and telephone systems in Berlin, Bremen, Hamburg and other German towns, via the radio stations at Norddeich, Cuxhaven and Swinemunde.



Loop Built in Lid of Portable Cabinet Is Adjustable for Directional Effect

Built-In Loop for Portable Set

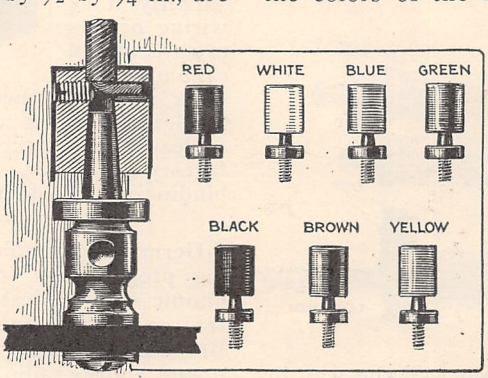
A good loop of the pancake type can be built in the lid of a portable receiver cabinet as shown in the illustration. The lid can then be adjusted in any position for directional effects. A loop of this kind takes up very little space, and is much handier than the folding type. Four strips of bakelite, 4½ by ½ by ¼ in., are slotted to take the loop wire easily. These slots can be cut with a circular metal-cutting saw and should be deep enough to take the wire. The turns should be spaced about ½ in. apart, and from 80 to 85 ft. of stranded silk-covered loop wire is used. The bakelite strips are countersunk for wood screws and mounted in the lid as shown. The wire is then wound on and the ends brought out through insulating blocks of bakelite to the cord-tip plugs. Note that the grid end of the loop is taken from the inner turn. Sufficient wire should be left at the loop ends so that the lid can be turned out as required.

Drilling Wood or Bakelite without Splitting

Holes can be drilled in wood or bakelite panels without risk of splitting out ragged holes on the underside, if a little care is taken. Always drill the hole from the front side of the panel and clamp the piece to be drilled tightly against a piece of wood of similar size and about 1 in. thick. This prevents the chips on the underside of the panel around the hole from breaking away. Use sharp drills, and a tapered reamer in cases where it becomes necessary to enlarge the hole beyond the size of bits on hand.

Colored Caps Indicate Leads to Set

Attachment caps made in seven distinctive colors, to indicate the different connections to the receiver and battery leads, are now available. They will fit any standard binding posts by removing the post screws, and replacing them with the screws of the attachment cap, or they can be used as a binding post by putting the screw through the panel and fitting a hexagon nut underneath. The threaded ends of the colored caps match the colors of the battery cables now in use, making it practically impossible to connect the set wrong. The caps are covered with insulating material, so that it is not necessary to keep them separated.



Safety Attachment Caps, in Seven Colors, Identify the Leads to the Set; Left, Binding Post with Cap

¶Radio station LRT, being installed on the South Orkney islands, is said to be the southernmost broadcasting outpost.

How to Improve Your Set

By F. L. BRITTIN

NO radio receiver is perfect; some approach perfection, but the large majority fall far short of the mark. The ideal receiver is still in the dim future: no science stands still and radio least of all. It is yet in the experimental stage in many respects, although the progress made in the last few years has been phenomenal. No matter what type your set is, many simple additions or corrections can be made that will improve the tone quality, selectivity, range and volume. These improvements, however, need not be of an expensive nature, if you study your own set and locate the imperfections. A word of advice is pertinent here. Do not listen to the say-so of every "expert" who comes along; his experience may have been with an entirely different type of set, and the remedy suitable for one circuit may be entirely wrong for the same symptoms in another.

There are several general rules to follow for best results that apply to all sets, such as well-constructed aerials, efficient grounds, and good batteries and tubes. We will not go into these general details as they are taken as a matter of course. The efficiency of any set is limited by the surrounding conditions, including atmospheric disturbances and interference from all sorts of electrically operated devices and power lines. These disturbing elements all work against good reception, no matter how excellent the set may be. The set itself, on the other hand, must not contain elements that add to the difficulties to be overcome.

Selective and easier tuning is an important factor in crowded cities, as the 10-kilocycle separation of wavelengths allotted by the government to the broadcasting stations is not sufficient to make tuning easy in locations where several stations are grouped together. Interference between stations having similar

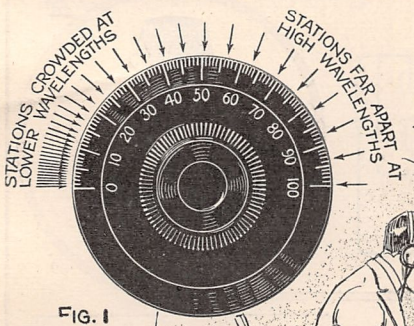


FIG. 1

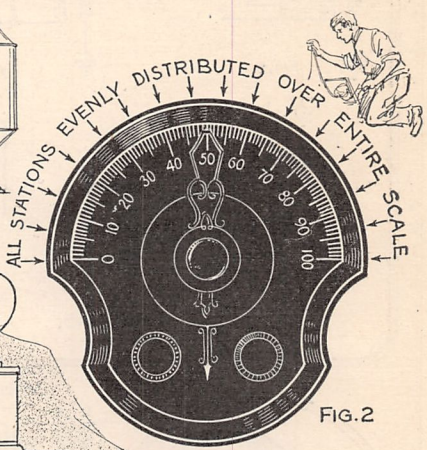


FIG. 2

FIG. 3

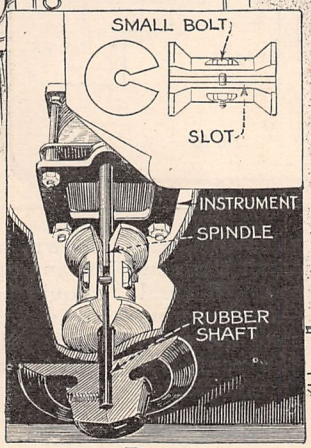
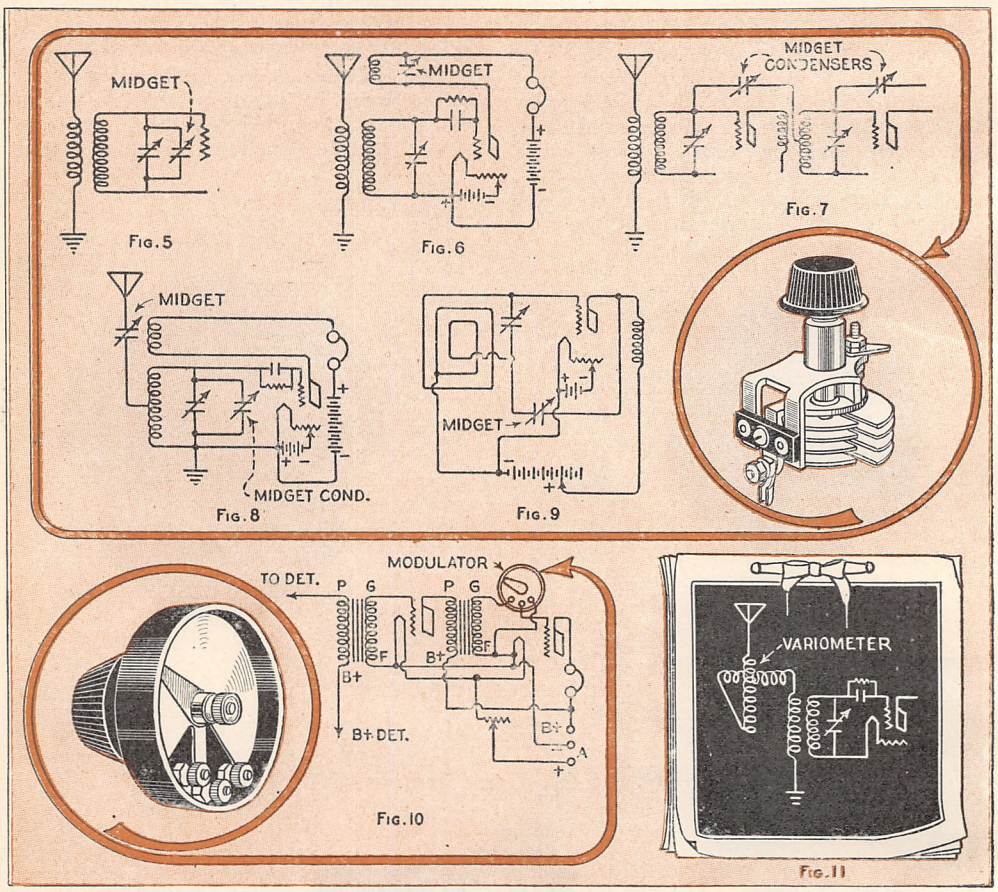


FIG. 4

wavelengths also often defies separation, although the stations may be hundreds of miles apart. Radio designers and manufacturers are striving to remedy the condition, and good progress has been made. Straight-line-frequency condensers, when used with the proper coils, have made possible a wider separation of stations over the dial. The crowding of the low-wavelength stations on the lower half of the ordinary dial with the common type of condenser is illustrated in Fig. 1. Many who have sets equipped with this type of straight-line wavelength condensers do not care to discard them, and the set, even if this is desired, may be so designed that it is not practical to install the new straight-line frequency type. Several manufacturers, therefore, are bringing out special dials that will make the common condenser approach the same result (see Fig. 2). This is accomplished by means of an ingenious arrangement of two gear trains, or a similar mechanism, within the front plate of the dial. The two trains move in such a way that, while one moves a pointer at a regular rate over the graduated scale of the dial, the other train rotates the condenser. This latter gear train works in such a way that, at the lower readings, the condenser moves faster than the pointer, causing the stations at the crowded low wavelengths to be separated on the scale and bringing the stations of higher wavelengths closer together.

A homemade logging plate is shown in Fig. 3, which can be placed behind the ordinary dial and is a simple aid in tuning. A disk of aluminum is cut in the form shown, and is fastened to the panel by means of a locknut or screws. The disk should be large enough to extend above the dial when in position, giving space for writing in the call letters of the various broadcasting stations. Tuning is often made difficult by body capacity; a station is tuned in and when the hand is withdrawn from the dial it is gone. There are several ways of correcting this de-



fect; a simple method is shown in Fig. 4, in a case (a very common one) where the live shaft of the condenser caused the trouble. A wooden spool was used to form a collar for a hard-rubber extension rod, and the condenser was remounted on the bakelite subpanel several inches back of the front panel, with the result that the hand capacity disappeared. Other methods of correcting hand capacity are grounding the rotor plates of the condenser, and shielding the back of the instrument panel.

One of the simplest ways of improving the set is the intelligent use of a midget, or balancing, condenser; there are a number of these little condensers now on the market similar to the one shown in the inset illustration under Fig. 7. They are very useful for vernier action, for neutralizing and for capacity regenerative feedback. The capacity of these condensers is very low, and the construction is along low-loss lines. Fig. 5 shows one of these little condensers used as a vernier on a large condenser; Fig. 6 shows an ideal method for obtaining vernier control of regeneration by tuning the tickler coil of the three-circuit tuner with the midget condenser. For those who have tuned r.f. sets not neutralized, or have old-type inefficient neutralizing condensers, the midget is a valuable addition to the set; Fig. 7 shows the usual method of neutralizing the tube capacities.

Those who would like to experiment with capacity antenna coupling, and the use of a vernier across the grid-tuning condenser, will find a wiring diagram in Fig. 8. Adding regeneration to the loop on tuned r.f. sets and superheterodyne receivers means better distant reception, and will appeal to all DX fans; Fig. 9 shows the method and the midget condenser turns the trick.

Volume control is a point sometimes overlooked in these days of fewer jacks, and the tendency to eliminate as many controls as possible. There are two very easy methods of controlling volume and tone quality by the addition of simple and inexpensive instruments to the set, as shown in Figs. 10 and 12. The instrument shown in the insert in Fig. 10 is a non-inductive variable resistance of the same general constructon and appearance as a potentiometer; this instrument is known as a modulator, and its resistance can be varied from zero to 500,000 ohms. When connected in the audio-amplifying circuit, as shown in the diagram, the modulator gives noiseless adjustment to any desired tone volume, from a whisper to maximum strength, greatly improving the quality of reproduction. The method shown in Fig. 12 is similar, but the instrument is here connected across the secondary of the last r.f. transformer, and consists of a variable resistance ranging from 10,000 to 120,000 ohms; it can also be used in resistance-coupled amplifiers.

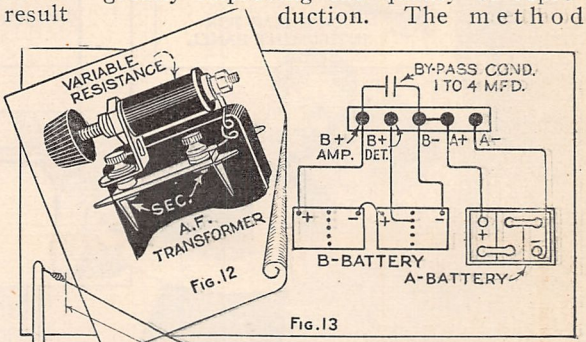


Fig. 12

Fig. 13

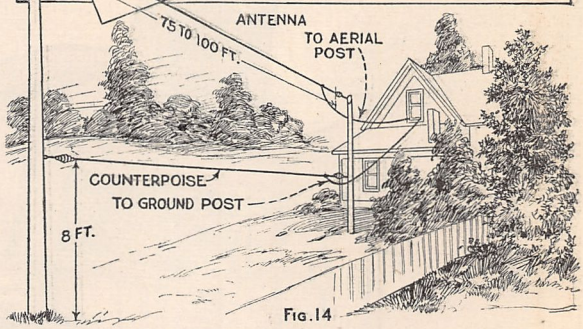
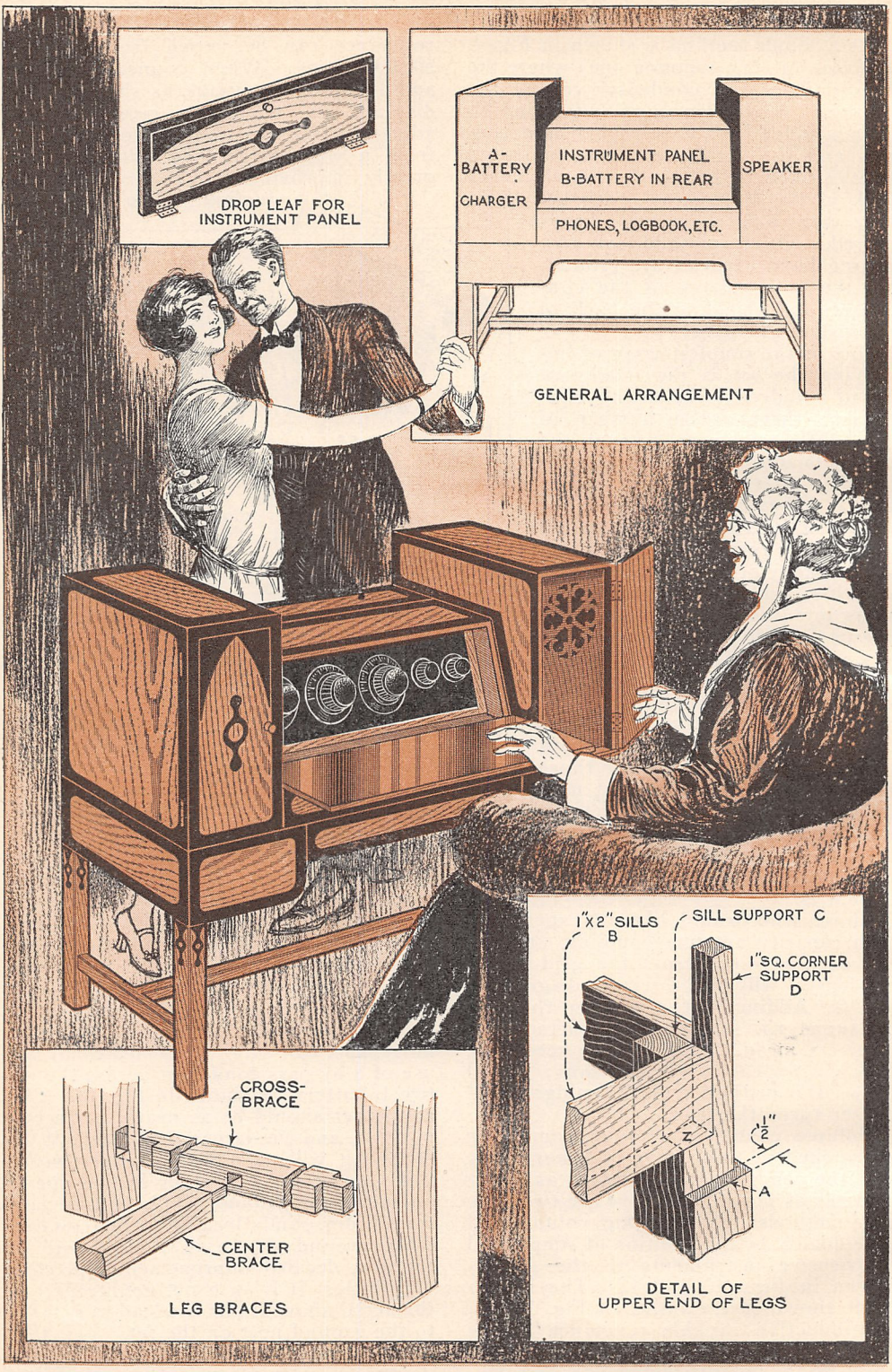


Fig. 14

If your receiver does not cover the broadcast wave bands as well as it should, the addition of a variometer in the aerial circuit, as shown in Fig. 11, will often give the desired result. If the set is noisy, this can often be remedied by the use of a by-pass condenser across the entire B-battery, as shown in Fig. 13. This condenser should be as nearly perfect as possible, and the larger the better; if defective, it will only make matters worse. Good sets often give poor results due to an inefficient ground. This is especially true in dry, sandy localities; the counterpoise ground shown in Fig. 14 will be found a decided improvement and costs very little. It is an exact counterpart of the aerial above it and the lead-in is taken to the ground post on the set. This type of capacity ground should be in general use, as, in most cases, it is more efficient than the ground available.



Various Details of Design of the Radio Console Cabinet, and Drawing of the Completed Cabinet, Showing Decorative Scheme

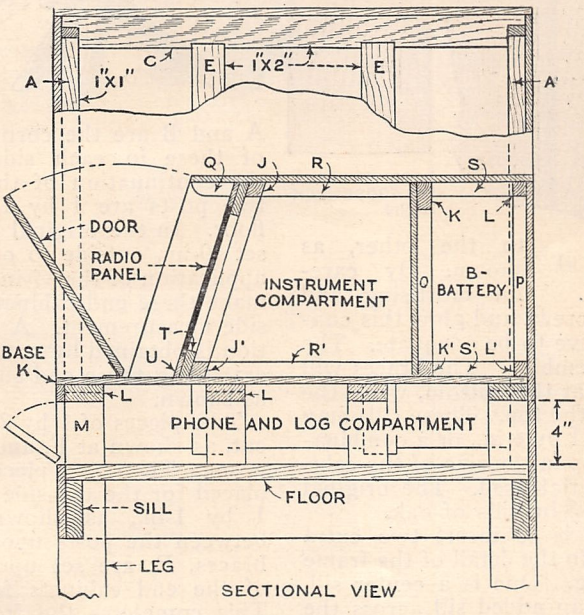
How to Build a Radio Console

By HERBERT C. McKAY

RADIO is universal, but its development has been largely that of efficiency. Appearances have been left to care for themselves with the result that today the radio set in most American homes means a small square cabinet, A, B and C-batteries standing upon the table near by, a loud speaker on top of the set, while logbook, phones and similar articles decorate the landscape. The home mechanic who is even moderately skillful in the use of tools, however, may assemble his own set and inclose it in a cabinet, at a total cost of less than $100, even in the case of the multi-tube sets.

The dimensions and even the details of design of the cabinet will vary with the different sets, so no exact measurements will be given. The drawings and text will give the reader sufficient information to enable him to build the cabinet which suits his particular set.

The set from which the drawings were taken was built to accommodate an 8 by 28-in. panel. The instrument inclosed was a five-tube, tuned radio-frequency set. The batteries used were one 6-volt, 100-amp.-hour storage battery, a Tungar charger, and two 45-volt B-batteries. The latter were of the upright, heavy-duty type. The speaker was of the paper-cone type. As this type of speaker is not as common as the horn type, two extra drawings have been included to show how to adapt the horn to the cabinet.

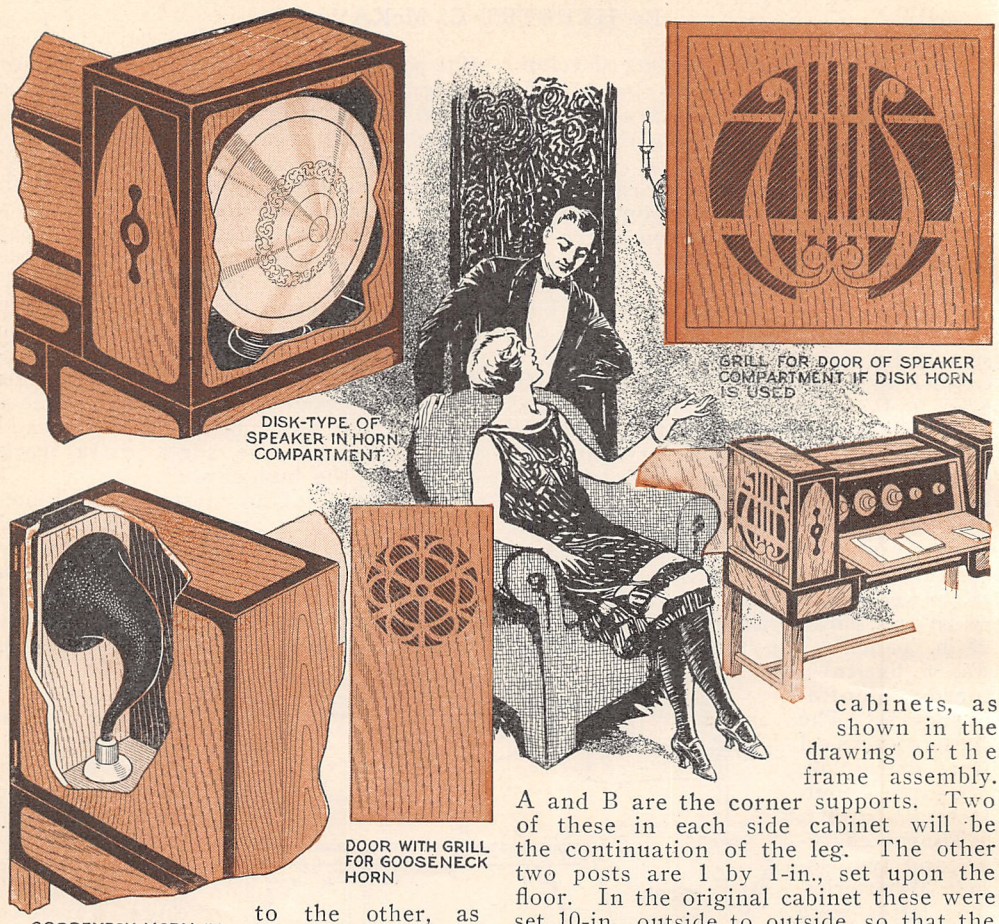


SECTIONAL VIEW

The full-page cut shows the front of the finished cabinet. The two-tone effect adds greatly to the homemade set. This finish may be secured in different ways. For example, the cabinet may be stained mahogany, the design then painted in with enamel, and the whole varnished. Another way is to stain the cabinet, then buy wood-grained paper such as is used by decorators and cut the design from this paper. In this case, the edges of the designs are painted black and the whole glued to the panels. A coat of varnish completes the work. These methods are makeshifts, however. For a really good job, the panels should be finished with cut-out designs in relief. For this work a thin veneer is obtained. Spanish mahogany from a cigar-box factory will serve beautifully. The designs are cut out, and laid out upon the panels before the cabinet frame is assembled. Then the legs are recessed deeply enough to compensate for this added thickness. In this case, the designs will appear as relief carving, with the contrasting tone to add attractiveness. The slight extra work will repay the builder well.

The first step is to construct the framework. The legs are cut from material 3-in. square. The two front legs may differ from the rear ones, depending upon the finish of the rear of the cabinet. If it is to be a four-square job, completely finished, all legs will be made as shown for the front legs, while, if the rear is to have a rough finish, the rear legs will be made as shown in the lower figure, detailing the legs. The difference between the two is only that, in the latter case, the legs are not recessed upon the rear side for the paneling. The perspective shows the construction clearly. First the ½-in. recess, A, is shown. The paneling sits flush in this recess. Above this are shown the recesses for the two 1 by 3-in. sills, at B. A portion, C, of the leg post is left to support these sills, while above is a 1-in. square of the original post, D, which supports the corners of the end cabinets.

Another detail shows the construction of the leg braces. Short crossbraces connect the two pairs of end legs, while a single center brace extends from one end


DISK-TYPE OF SPEAKER IN HORN COMPARTMENT
GRILL FOR DOOR OF SPEAKER COMPARTMENT IF DISK HORN IS USED
DOOR WITH GRILL FOR GOOSENECK HORN
GOOSENECK HORN IN POSITION

to the other, as shown. By careful mortising and the use of both screws and glue, this construction will prove to be adequate. The frame is now assembled. The braces will support the legs at the bottom, while the sills will support the top. These sills may be 1 by 2, 1 by 3, 1 by 4-in., or a combination, depending upon the size of the cabinet and the material used. The original cabinet had 1 by 3-in. sills of oak.

The next step is to insert two extra braces, as shown in the detail of the frame ready for flooring. One is a center sill, and the other is an added sill across the battery compartment to support the extra weight at that end. This view shows paneling in place for a rough-finish rear, while the drawing below shows the paneling for a finished rear.

The frame is now floored with ceiling material, or regular flooring. This is cut flush with the sills, so that the paneling will cover the edges of the flooring boards. The next step is the framing of the end cabinets, as shown in the drawing of the frame assembly. A and B are the corner supports. Two of these in each side cabinet will be the continuation of the leg. The other two posts are 1 by 1-in., set upon the floor. In the original cabinet these were set 10-in., outside to outside, so that the application of the ½-in. plywood paneling make these end cabinets 11 in. wide, outside measurement. A stronger construction is obtained by notching the floor and extending these end supports to the sills, as shown.

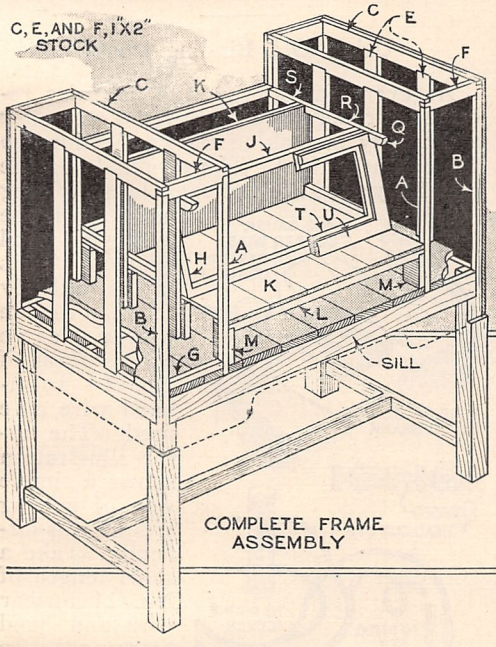
Two pieces of 1 by 2-in. stock are then cut, as shown at F, and set upon the end posts. Then two pieces, C, are cut and placed for the top-side supports. Pieces, 1 by 1-in., as shown at G, are set between the posts upon the floor. Now braces, E, are set upon the inner sides of the end cabinets for added support. This completes the framing of the side cabinets. The next step is to apply the panels on the inside of these cabinets. This is necessary, as the framing of the radio cabinet proper is secured to this paneling.

The frame-assembly drawing shows the completed framework, except that these two panels have been omitted for the sake of simplicity. It is to be assumed that these panels are in place between

the framing of the end cabinets and the radio cabinet itself. End supports, M, are cut 4 in. long, and beams, L, secured to them. Upon these, the radio-cabinet floor, K, is laid. This should be one piece in front of the panel, in order that the best finish may be obtained.

Referring now to both sectional view and frame-assembly drawing, bottom beam J^1 is laid in. Then lower beams, K^1 and L^1, are laid in place and secured. Next, uprights, H, O and P, are secured to the paneling of the side cabinets. Upon these are laid the upper beams, J, K, and L, as shown. Then cross beams, R and S, are secured to the side panel, as are the corresponding lower cross beams, R^1 and S^1.

The panel supports, T, are now placed in position. Uprights are not needed here, although they may be added if desired. To these are secured the panel-frame members, U. These members should be the thickness of the panel and 1 in. wide. These form a support and frame

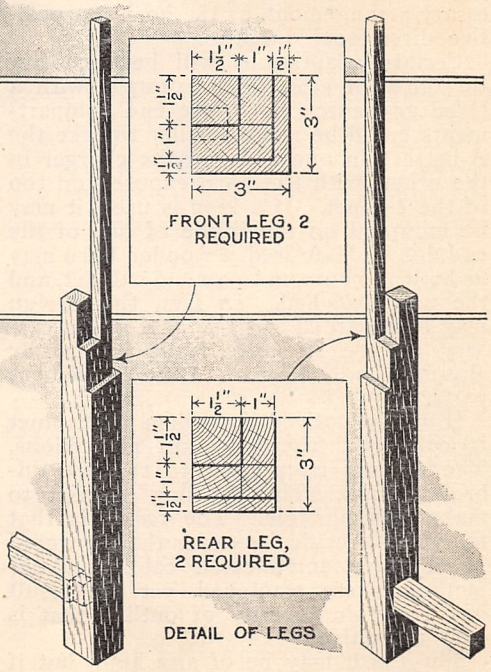


COMPLETE FRAME ASSEMBLY

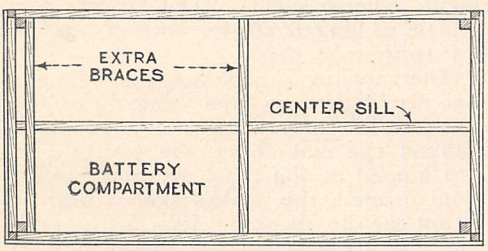
for the panel, giving a more finished effect than if the panel completely filled the cabinet front. It may be said here that the sloping panel is used only for the improved appearance. The upright panel is just as easily added. The partition between the instrument compartment and the battery compartment is placed against uprights, O, and beams, K and K^1. Now the top support, Q, is attached to the cabinet panel, and the radio compartment is ready for covering. This cover may be hinged in the middle, which gives a more symmetrical appearance, or it may be hinged at the upper beam, K, for easier access to the instrument compartment. The front door, which is hinged at the bottom, may be left to the last step.

The paneling is now applied. The end-cabinet doors may be hinged as best pleases the constructor. In the original cabinet the end doors, the square ones, are hinged at the top. As they are seldom opened, this makes the natural position the closed one. Also, in the original, the front panels of these compartments were fixed in place. This was due to the fact that the non-directional disk speaker was employed. For the horn, it will be necessary to make a speaker panel in the front of the speaker compartment, and this compartment must have a door to open this panel to the room. This door may be hinged at the inside, or it may be hinged to the larger door. In this case, opening the larger door will also lift the front door and expose the whole compartment.

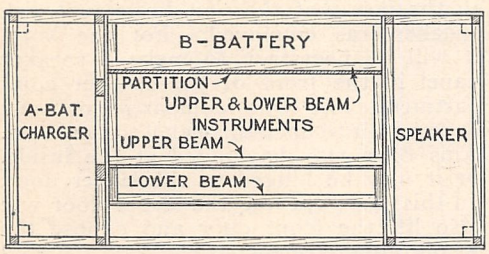
In the original cabinet, the 18-in. disk speaker occupies a place as shown in the perspective detail. It practically fills the compartment. This cabinet is placed so that the speaker compartment faces the longer open side of the room. In



the door of this compartment a design was fret-sawed, as shown. This was lined with brown silk. Thus, the reproduction from the hidden speaker was quite satisfactory. In case a horn is used



FRAME READY FOR FLOORING



PANELLING FOR FINISHED REAR

it will be placed as shown in the lower drawing. This requires a small horn. A supplementary panel, as shown in the full-page drawing, is placed just behind the front door. Thus, by opening this door, the horn is directed into the room, a necessary arrangement, as the horn has positive directional qualities.

Certain adaptations will be necessary for different sets. For example, with a large gooseneck horn, the end compartments could be made smaller to take the A-battery in one end and the charger in the other, with the horn exposed on top of the cabinet. If a loop is used, it may be mounted on the inside of one of the end doors. If desired, a wooden horn may be built to conform to an end cabinet, and the unit attached. In fact, this design may be regarded as basic, and any necessary change is easily made by merely altering the dimensions of the component parts.

It will be noticed that when the cabinet is completed there are no projections. The corners from floor to top are unbroken lines. The paneling is inset to make this possible. The result is that the work is made far easier than it would be if more complicated cabinetmaking methods were employed, yet the result has a certain severity of outline that is very attractive.

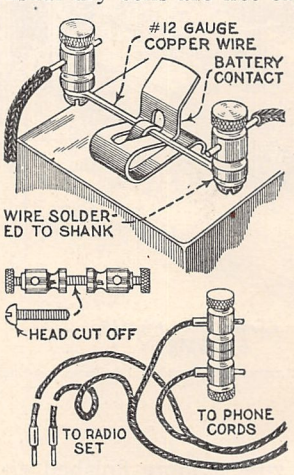
The finish may be of any kind, but if no other finish is especially desired, the fret-sawed two-tone effect cannot be surpassed for simple yet elegant appearance.

Dust between Condenser Plates Causes Volume and Selectivity Loss

In many cases of trouble with radio-receiving sets the cause is some trivial thing that escapes the eye. Dust between condenser plates is one of these; sets will become noisy, lose volume and selectivity under such conditions, because dust particles form sharp points on the surface of the conductors permitting the energy to leak across to the other plate. Dust-proof condensers are now available, some completely shielded in a metal case, others provided with a dust-proof transparent shield of celluloid. If the condensers are not covered in such a manner, it is necessary to clean the plates with a pipe cleaner or similar brush. Make it a rule to do this at intervals, even if the plates look clean.

Using Old Binding Posts

As every fan knows, the batteries required for the newer-type radio sets offer a difficulty in making the connections to the contacts rigid. The terminals on the usual dry cells are not capable of holding more than one lead with good contact. This is especially true if the proper-size battery leads of No. 14 insulated wire are used. The upper illustration shows a simple way of getting around this difficulty. Take a short length of No. 14 busbar wire and bend the ends to hold a standard binding post securely. Solder this shank of the post to the end of the wire to make an absolute contact. Compress the battery terminal so that the special connection can be slipped under the projecting hook part of the battery terminal. If this is provided with knurled nuts, the busbar wire carrying the binding posts should be longer, with a loop formed at the center to slip over the terminal post.



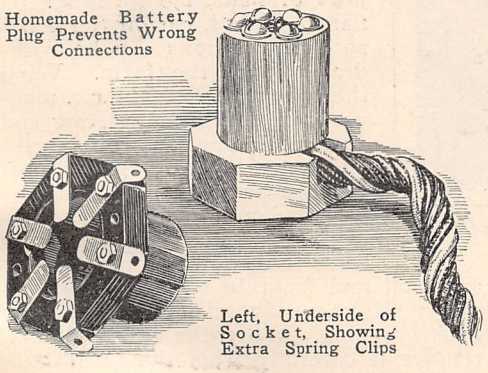
The two binding posts provide an easy method for making quick changes in the battery connections, and do not put an unnecessary strain on the terminals.

Another handy use for old binding posts is illustrated below; the head is cut from the machine screw furnished with the binding posts, and this screw is then used as a connection for the two posts, making an ideal connector for placing two or more sets of headphones in series.

Homemade Gang Plug and Socket Save Tubes

Radio experimenters who frequently test out new circuits or apparatus are worried by the risk of wrong battery connections, which may be overlooked in the usual impatience to test the new devices.

One experimenter has made his battery connections fool-proof by always using a tube socket for the battery terminals in the receiver, then connecting the leads from the batteries to a wooden plug made to fit the tube socket. The socket is of the common type with extra clips mounted on the base. The six spring clips take care of the A, B and C-battery connections. An ordinary four-prong socket can be used if the set requires only four battery connections such as A+, B—, B-22 and B-90. The plug is drilled to take the required number of machine screws, which act as contacts, and the various battery leads are then soldered to the ends of these screws. The wood base is hollowed slightly for the plug, and a small section is cut away for the leads which are twisted in cable form.



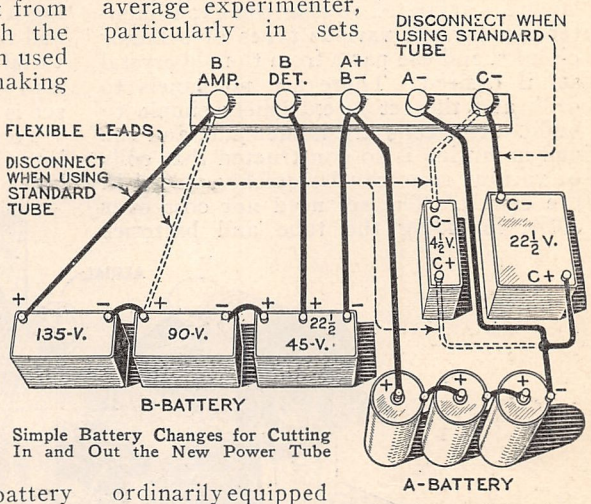
Homemade Battery Plug Prevents Wrong Connections

Left, Underside of Socket, Showing Extra Spring Clips

A pin in the side of the plug prevents wrong insertion of the plug in the socket, and the experimenter is always sure that all batteries are correctly connected.

Simple Battery Changes for New Power Tubes

The installation of the new power tubes seems to offer some difficulties to the average experimenter, particularly in sets ordinarily equipped with only one stage of a.f. amplification, and those which have two stages but will operate the loud speaker only on the last stage, and even then with too little volume to suit the operator on distant stations. On the other hand, the volume on the last stage may be too great for locals, and some simple means for cutting out the power tube when not required is desirable. All this can be handled nicely by the arrangement shown in the diagram.



Simple Battery Changes for Cutting In and Out the New Power Tube

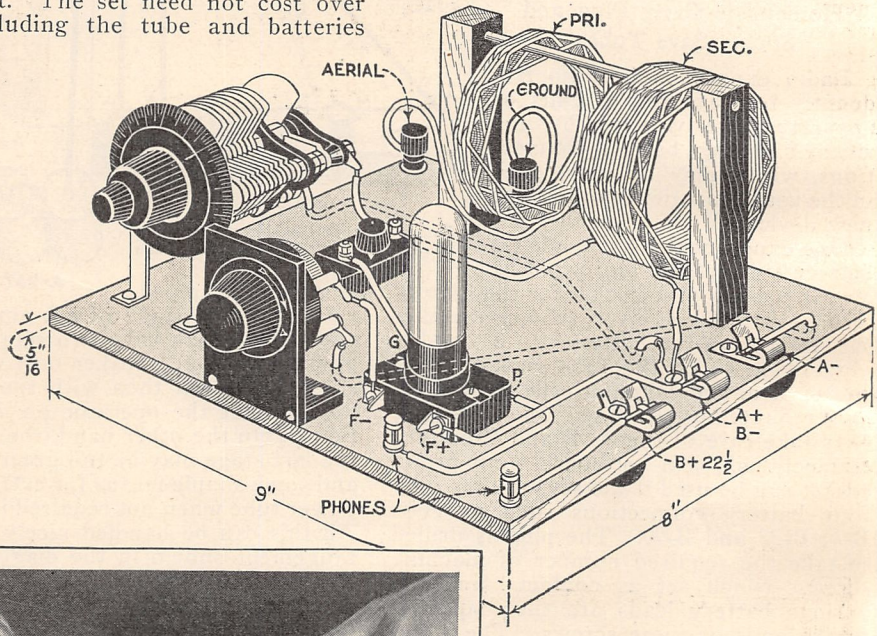
A socket of the new standard UX-type, which will take the 3-volt and 5-volt tubes as well as the common type, is provided. Inspection of the diagram will reveal a simple but effective method of changing the ordinary C-battery connections, as well as the necessary shift from 135 to 90 volts of B-battery suitable for cutting out the power tube and replacing it with the standard-capacity tube for local reception on the loud speaker. The diagram shows the 22½-volt C-battery used with the 3-volt power tube; if the 5-volt tubes are used with the 135-volt B-battery, it is necessary to have a 9-volt C-battery instead of the 22½-volt unit. The writer estimates that the change from power to standard-capacity tubes can be made with this arrangement in less than three minutes. The power tubes are fine for distant reception but for local work the standard tube will give better quality of tone. The diagram given is suitable for the small-tube super set now in general use, where one stage of audio amplification is used.—L. H. Georger, Buffalo, N. Y.

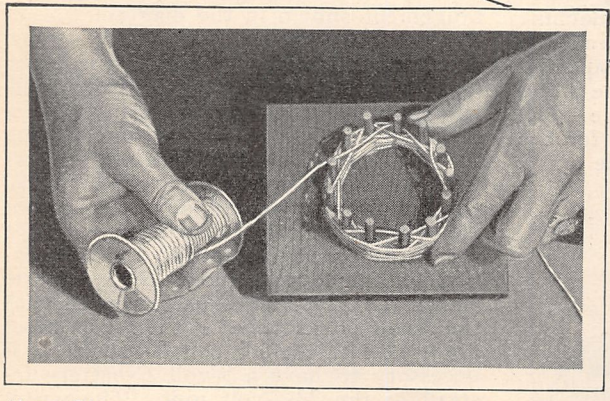
A Cheap and Efficient Dry-Cell Tube Set

By JOSEPH SHOGREN

THIS set is especially designed for the beginner who is ready for the step from the crystal receiver to the tube. The layout is arranged so that the experimenter can try out various types of detector circuits, and use parts from the old crystal set if desired. There are no panels to drill, and the set is extremely simple to build. The coils are homemade, and the coil mounting is so constructed that coils of various sizes can be quickly placed in the circuit. The set need not cost over $9.50, including the tube and batteries but not the phones. A good pair of 2,000-ohm phones can be obtained for $3.50, however. Receivers of this type are not toys, but really efficient instruments, bringing in stations 500 to 600 miles away during silent night in Chicago, with good clear reception. The set is fairly selective, as the coupling between the coils can be varied, if flexible leads are used, by sliding the coils along the rod. Selectivity can be further obtained by using a larger primary coil, tapping off the coil to an inductance switch; a .0005-mfd. variable condenser in series with the aerial lead will also provide closer tuning, if the set is used near powerful stations.

To make the form for winding the coils, inscribe a circle, 2½ in. in diameter, on a block of wood, point off thirteen holes at equal distances around this circle, and with a hand drill sink holes for thirteen wooden pegs or nails, 2½ in. long. If nails are used, cut off the heads so that the coils can be withdrawn from the form. Wind the coils with No. 22 d.c.c. magnet wire, leaving a starting end 4 or 5 in. long, and winding in and out over two pegs and under two pegs; mark one of the pegs and count each turn as this peg is passed. Fifty to sixty turns are wound on the secondary coil, and from 16 to 40 on the primary. Make up several primary coils for experimenting. When the coil is wound, remove it carefully from the form, and, with light string or heavy thread, sew in and out through the holes left by the pegs, tying the ends of the thread so that the coil will retain its compact shape.





Above, Diagram of Connections of the One-Tube Receiver; Below, Method of Winding the Coils

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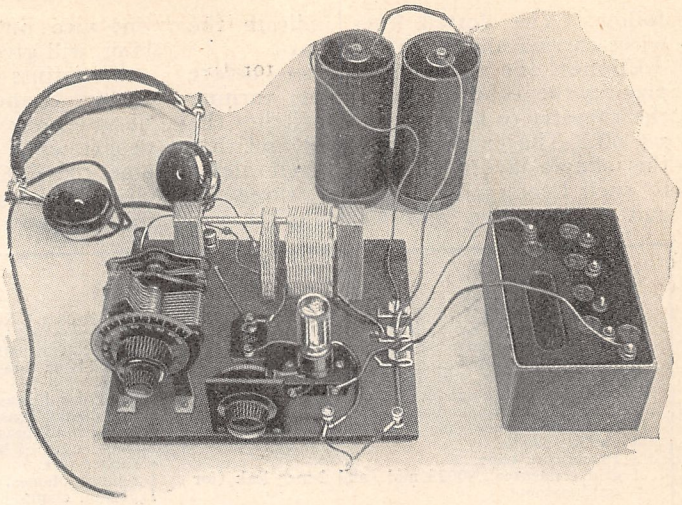
The detail of the wood uprights for the coil support and rod are given in the diagram. The holes for the rod should be large enough so that it can be slipped out when the coils are changed. The wood baseboard is 5/16 by 8 by 9 in., and four rubber feet are used to elevate it above the table. The instruments should be arranged on the board as shown in the wiring diagram; the variable condenser is mounted on two brass brackets, which are drilled ½ in. from the top to take the condenser-mounting screws, and at the base for two wood screws. It should be of the type having extra vernier plates, if possible, although the non-vernier type can be used if the other is not available. The rheostat is of the 25 or 30-ohm type suitable for the UX-199 or CX-299 tube, and is mounted on a bakelite or wood mounting, as shown. This mounting bracket is 2 in. wide and 2½ in. high; the gridleak and grid condenser are mounted directly behind the rheostat, the type shown being a combined unit with a variable leak. A separate .00025-mfd. condenser and 2-meg. gridleak can be used, however. Note that one side of the grid condenser and gridleak goes to one side of the variable condenser and also to the secondary coil; the other side of the leak and grid condenser goes to the grid post on the tube socket. The tube socket is of the type suitable for the new 3-volt tubes, and will also take the new 5-volt UX-201A and CX-301A, if the builder wishes to use one of these. In this case, it will be necessary to employ an A-battery of four No. 6 dry cells connected in series, while the B-battery remains the same and no other change is necessary. The binding posts for the ground, aerial and phones are mounted on the base in the positions shown; the A and B-battery terminals, arranged at the edge of the baseboard, are Fahnestock clips and are fastened with short wood screws.



Complete Set, Showing Batteries and Phones Connected

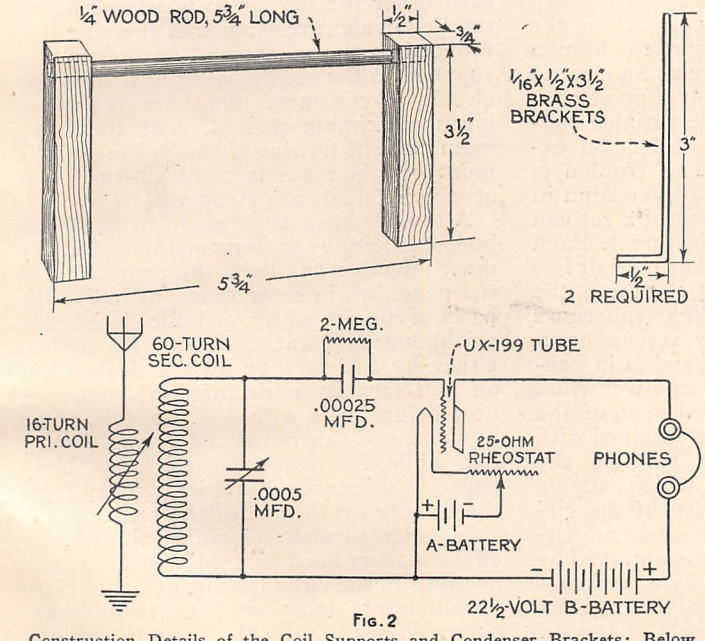


FIG. 2

Construction Details of the Coil Supports and Condenser Brackets; Below, Schematic Diagram of the Circuit

The set can be wired with the No. 22 d.c.c wire left over from the coils; black-spaghetti tubing can be used on this wire where necessary to prevent possible shorts. A schematic diagram of the wiring is given, but if the picture diagram is followed and each wire run exactly as shown, good results are sure to

follow. The dotted lines indicate the wires carried under the baseboard.

Connect the A and B-batteries before placing the tube in the socket; turning the rheostat to the off point switches the set off. The experimenter will find that this simple layout will lend itself nicely to such hookups as the reflex, three-circuit regenerative and ultra-audion. A one-wire outdoor aerial, 75 to 100 ft. long, will give the best results.

Blueprints of the wiring diagram, and battery connections for using either type of tube may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario Street, Chicago. Inclose 15 cents to cover postage and packing. Specify blueprint No. 107.

MATERIAL LIST

1 wood baseboard, 5-16 by 8 by 9 in.
2 pieces wood, ½ by ¾ by 3½ in.
½ lb. d.c.c. magnet wire.
1 wood rod, ¼ by 5¾ in.
1 7-in. brass strip, 1-16 by ½ in.
1 vernier variable condenser, .0005 mfd., and dial.
1 rheostat, 25 or 30 ohms.
1 tube socket, new, for UX-199 or CX-299 tube.
4 binding posts.
3 Fahnestock clips.
1 grid condenser, .00025 mfd., and 2-meg leak (for combination).
1 UX-199 or CX-299 tube.
2 No. 6 dry cells.
1 22½-volt B-battery unit.
2 round-head brass machine screws, 6-32, ½ in. long.
4 round-head brass wood screws, ¾ in. long.
5 round-head brass wood screws, ⅜ in. long.
4 round-head brass wood screws, ½ in. long.
1 2-ft. length of black-spaghetti tubing.
4 rubber feet.
1 set headphones, 2,000 ohms.
1 ground clamp.

How to Overcome Body Capacity

Every radio fan has heard of body capacity until he is tired of it, and it is safe to say that nearly all of them have had their own troubles with it. Be that as it may, most of them would have better luck if they had a better understanding of what it really is. What is this mysterious force that often upsets the finest tuning with unruly squeals, and what is the best way to overcome its effects?

Body capacity, or hand capacity, is the term applied to the property of the human body which makes it behave as an electric condenser. The body is not a good condenser. Compared with the variable condensers in a receiving set it has an extremely small capacity. The trouble is that even an extremely small variation in either capacity or inductance of a set can throw fine tuning out of adjustment. Each time the operator's hand takes hold or lets go of a knob in the process of tuning, the capacity of the set varies slightly, because some of the body capacity is communicated to the set while the hand is in contact with it. Then you know too well what happens. A very fine adjustment of the total capacity of a set can be obtained with modern vernier knobs for rotating the parts of the condensers, which supply practically all of the capacity of the circuit. In the same way a very fine adjustment of the total inductance is obtained by rotating the parts of the coils which supply nearly all of the inductance in the circuit. Thus these two elements in the set itself can be very closely controlled. Body capacity, while small enough in itself, is quite beyond control. That is why, if it is allowed to act on the set at all, it is likely to upset the whole scheme.

Some radio enthusiasts who can build anything from a pocket crystal set to a superheterodyne do not know just why this adjustment of capacity and inductance values is so important in its effect on reception. The reason, technically, is that when these values are properly related to each other for any given wavelength, the total equivalent resistance of the circuit is reduced to the minimum. As the voltage supplied to the set by batteries or lighting circuit is constant, minimum resistance means maximum current. With the maximum current flowing through the set, the point of resonance is reached—the point at which signals are strongest.

Attempts have been made to eliminate body capacity by various methods, but the most effective has been the protection of the panel, or, in some cases, of individual parts of the set, with a metallic shield. The shield, until recently, had to be applied either by the user or by the dealer, but an anti-capacity panel of hard rubber is now being made with a shield vulcanized in place, and this is very effective. Shielding, while decreasing the effects of body capacity, does not detract in any way from the quality or volume of the tone.

In order to make shielding thoroughly effective, care must be used in making connections in the circuit. The grid and plate terminals are most sensitive to body-capacity effects. Keep the parts of the coil or apparatus to which the grid or plate is

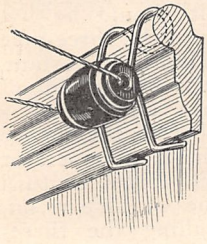
connected as far as possible from the panel. The filament circuit must be properly grounded. When variable condensers are mounted on the panel, connect the rotor plates to the ground or filament side. There are variable condensers on the market with end rotor plates, which can therefore be termed self-shielding. With a series condenser in the antenna, the rotor plates should be connected to the antenna; with the condenser in the ground circuit, the rotor plates should be connected to the grounded side. A condenser across the secondary should have the stationary plates connected to the grid.

With a variometer in the secondary circuit, the stator end is connected to the grid; in the plate circuit, the stator end is connected to the plate. Where a tickler is at the end of an inductance, which is the case with many variocouplers, the end of the coil farthest from the tickler end should be connected to the grid.

In locating the sockets, keep the grid and plate terminals farthest from the panel, and place the filament leads toward it. It is helpful also to shunt the phones with a fixed condenser of .001 or .002 mfd. capacity, or if amplification is used, to connect a fixed condenser across the plate terminal of the detector tube and the negative side of the B-battery.

Picture-Molding Clamp for Indoor Aerial

An insulated support for indoor aerials that clamps on the picture molding has made its appearance on the market. It consists of a tubular porcelain insulator mounted on a wire clamp. This can be firmly attached to any standard picture molding, without the use of nails or screws. The-around-the-room aerial has almost the capacity of the outside aerial for volume, and the selectivity will not be impaired by its use.

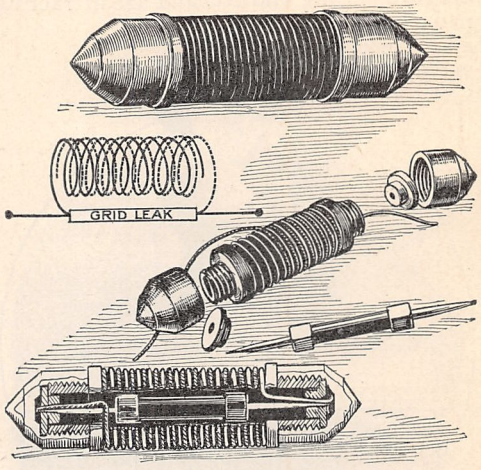


International Radio Week Tests

Popular Mechanics Magazine is interested in hearing from readers that have built sets described in the Magazine who were successful in bringing in distant stations during the International Radio week tests, Jan. 24-30, this year. Please state the type of set used and send a copy of your log.

Combined Gridleak and Condenser

Grid condensers are usually furnished with clips for holding the gridleak. A compact unit, which combines both the condenser and leak, is now on the market, however. It consists of a pair of wires, coated with a special insulating material and wound in parallel, in a single layer, upon a bakelite bobbin. One wire is connected to one cap and the other wire to the opposite cap, as indicated in the drawing. Each wire has one open end and one end connected to a terminal, thus forming two plates of a condenser. The method of winding is claimed to insure that the spacing between them can vary only a trifle, which gives extreme uniformity. The gridleak is suspended in the center of the bakelite bobbin on which the wires are wound, and the ends of the leak are connected to the caps as the wires. This completes the arrangement and the caps are then screwed down tightly.



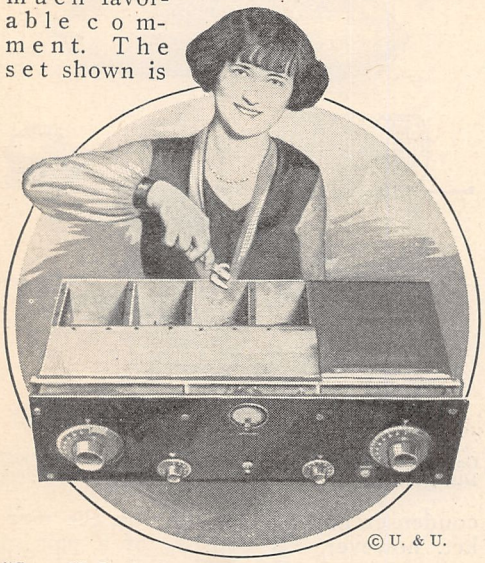
Combined Grid Condenser and Leak Assembled, and Disassembled to Show Parts and Method of Winding

Dry Cells Are Rechargeable

In a new rechargeable dry cell the container is a cylindrical zinc plate which serves as the negative electrode, and the positive plate an especially designed grid said to prevent the active materials from falling out. The moisture needed by the battery from time to time is supplied by adding two or three eyedroppers full of distilled water every two or three months. The cells may be used singly, but generally are put up in six-cell units in cabinets, with built-in rechargers; the whole outfit is then connected with the radio set and the 110-volt house-lighting supply.

"Canned" Radio Set Eliminates Body Capacity

Radio sets having shielded units are known as "canned" sets. Several types are now on the market, and are attracting much favorable comment. The set shown is



© U. & U.

"Canned" Radio Set, Showing the Various Units Inclosed in Metal Containers

one of the tuned r.f. type and is inclosed in nickeled brass; each tube is shielded in metal stalls, eliminating body capacity and adding much to the efficiency of the set. The fields of the various coils also are confined, limiting the troublesome stray pick-up which is so common with the unshielded types.

Simple Connections for A-Battery Charger and B-Eliminator

The problem immediately confronting the radio builder, or the purchaser of a new set, is proper connections for the A-battery charger and the B-eliminator. A number of switches are not desirable, the fewer operations necessary the better. The diagram herewith works out nicely, and the method is so simple that anyone can use it. A three-pole double-throw switch, a wall socket of the pull-apart-type and the necessary lengths of lamp cord are required. If there is no wall socket near the set, an extension cord can be used. If the set is of the cabinet-type the pull-apart socket may be mounted at any convenient point near the set; if a console is used, the lamp cord is brought in through the rear of the battery compartment and the socket mounted on the inside. Mount the switch at a convenient point, and run the wires as shown in the diagram. Two leads are taken from the one side of the wall socket so that the 110-volt a.c. supply is available for both the charger and B-eliminator; note that the other side of the supply line goes direct to the switch-lever post. The other two lever-posts are connected to the positive and negative terminals of the 6-volt A-battery; mark these terminals on the switch so that the corresponding leads to the set and the charger will be of the right polarity.

When placing the A-battery on charge, plug the charger into the wall socket, and throw the switch over, connecting the charger to the battery and at the same time automatically cutting in the a.c. supply. When taking the battery off charge, pull up the switch to the off point, and remove the charger plug; the B-eliminator plug is then pushed into the wall socket instead. When ready to operate the set the switch is thrown to the set connections, and the B-eliminator is automatically placed in operation. There should be no filament switch on the panel of the set as this three-pole switch turns on the A-battery supply to the tubes and puts the set in operation. If there is a switch on the panel, it should be left turned on at all times, and the three-pole switch used instead. This is important, as the B-eliminator must be turned off when the set is not in use, and if there is more than one switch, there is the chance that the operator will forget to turn one of them off. Pulling the three-pole switch to the upright position turns off all electrical connections.

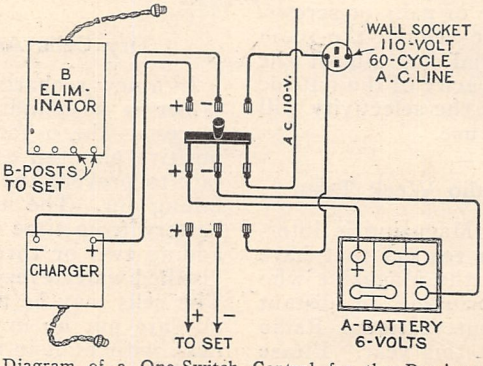


Diagram of a One-Switch Control for the Receiver, Battery Charger and B-Eliminator

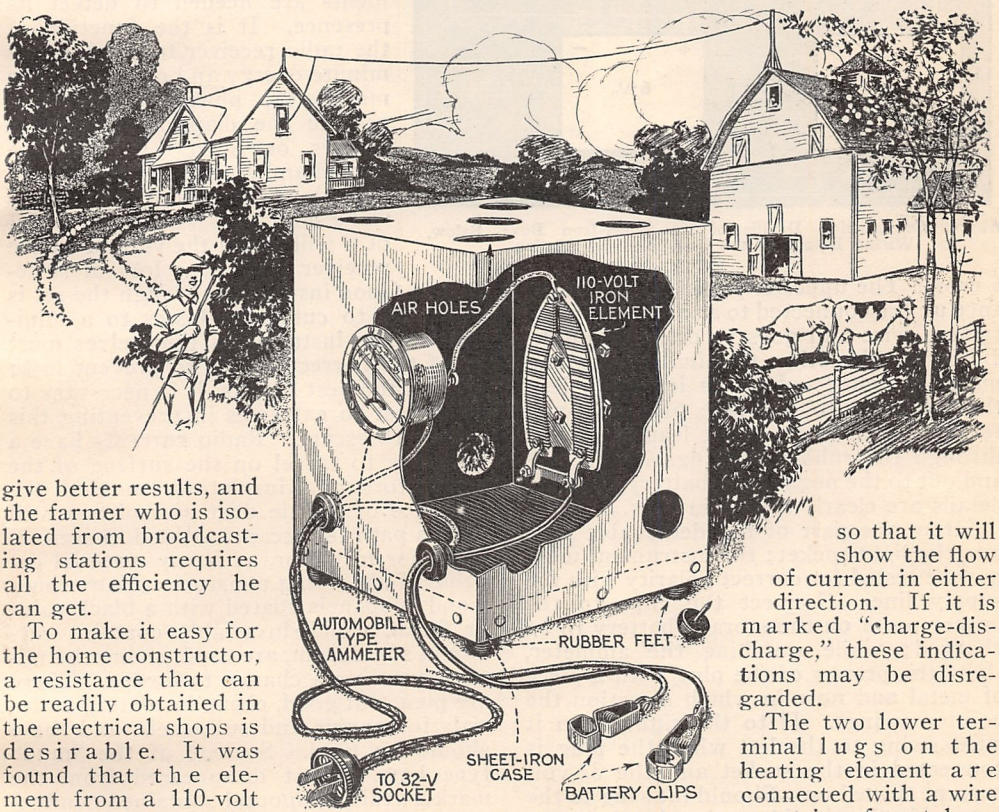
¶For DX reception more volume can be obtained if the full rated plate voltage from the B-battery is used on the amplifying tubes.

Radio-Battery Charger for Farm Lighting Plant

By E. J. BACHMAN

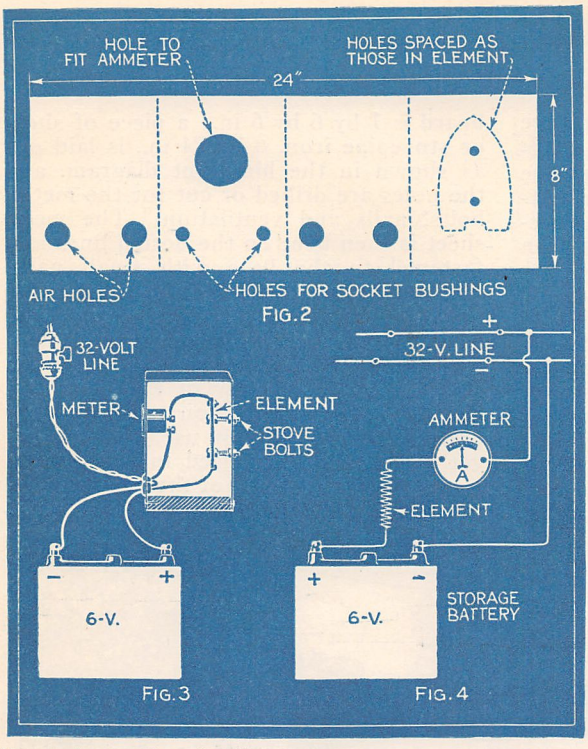
CHARGING the 6-volt radio storage battery from the 32-volt farm-lighting plant is a simple matter if a suitable resistance is used in one of the connecting leads, and the polarity of the connections is correct. It is not a good plan to tap off the A-battery supply from the plant itself as many try to do. A good 6-volt radio storage battery costs very little and will last a number of years if properly maintained. Regular charging is necessary for best results, and as very few farms are equipped with the current supply necessary to use the standard charging apparatus, many farmers have limited themselves to sets using the small dry-cell tubes. The storage-battery tubes give better results, and the farmer who is isolated from broadcasting stations requires all the efficiency he can get.

To make it easy for the home constructor, a resistance that can be readily obtained in the electrical shops is desirable. It was found that the element from a 110-volt electric iron, which can be bought for $2 or less, met the required specifications, when connected as shown in the diagram. The element was inclosed in a neat sheet-iron box and an auto-type ammeter gives the completed unit a factory-built appearance. The baseboard is 1 by 6 by 6 in.; a piece of sheet or stovepipe iron, 6 by 24 in., is laid out as shown in the blueprint diagram, and the holes are drilled or cut for the meter, bolts, nails and ventilation. The metal sheet is then bent on the dotted lines and fastened to the base with small nails. Rubber-headed tacks are used under the base for feet; after the sides and base have been assembled, mount the element with two ¼ by 2-in. stove bolts and nuts, so that it stands clear of the back and sides, to allow dissipation of heat. The element will warm up in use, but does not get so hot as when used in the electric iron. The ammeter is of the common automobile-dash type, with a 20-0-20 scale, so that it will show the flow of current in either direction. If it is marked "charge-discharge," these indications may be disregarded.



Radio-Battery Charger for Farm-Lighting Plant; Broken-Out Section Shows the Instruments in Position and the Wiring

The two lower terminal lugs on the heating element are connected with a wire or strip of metal, as shown in the detailed illustration; from this point an insulated lead wire is brought out through a rubber bushing, in the front of the case, to a battery clip. This terminal will be positive, as shown in Fig. 4 in the blueprint diagram, so mark this clip with



Above, Construction Details of the Sheet-Iron Box; Below, Wiring Details of the Completed Installation

a cross. The upper terminal of the resistance unit is connected to a short lead of insulated wire and goes to one side of the ammeter; the other terminal of the ammeter is connected to an insulated lead that is taken to one side of the 32-volt socket. The other socket lead is carried through the rubber bushings in the case and out to the negative A-battery clip; the details are clearly shown in Figs. 3 and 4.

Screw one part of the detachable plug into the light socket; the instrument must now be tested for correct polarity with the supply line. Connect the clips to the proper posts on the storage battery to be charged; while watching the ammeter, short the prongs of the plug with a piece of metal and note in which direction the pointer swings. If to the right, then it must swing to the left when the plug is connected in the socket and the 32-volt current turned on. Should it swing to the same side that it did on the shorting test, pull out the plug and insert the pins in opposite holes, reversing it. Shorting the plug in this manner will not harm anything, as the resistance is in series. Connecting the plug in the wrong direction momentarily, will not matter for the same reason. The main point to remember is that, to charge the battery, the indicator must swing in the opposite direction to that in which it swings when shorting the pins of the detachable plug.

Poor Insulation Is Cause of Leakage

To really appreciate the chances for losing the energy picked up by the aerial before it reaches the set, and in the set before it can be built up to the point required for phone or loud-speaker volume, it is necessary to know something of the minute and feeble character of these impulses. The amount of energy picked up from distant stations by the aerial is so small that very delicate instruments are needed to detect its presence. It is the function of the radio receiver to amplify this minute energy and convert it into mechanical power sufficient to actuate the diaphragm of the phones or horn. It must be nursed and guarded so that it will flow along the path by which it is to be built up. To lose any part of it will lessen the volume of the receiver and cause loss of selectivity. Good insulation through the set is necessary to cut these losses to a minimum. The instruments themselves must be of the correct design to prevent loss; in fact, for best results, it is necessary to go almost to extremes in preventing this energy to escape. Radio currents have a tendency to travel on the surface of the conductors and insulators, so that the presence of a little dust or moisture will offer a path for escape. Wood, therefore, is a poor insulator, as is any material capable of absorbing moisture. Many times wood subpanels coated with a black paint or finish, which invariably contains carbon in some form, are used, giving the minute currents a chance to escape. There are plenty of good, cheap insulating materials for panels and subpanels, and these should be used. Sockets of the "mud" type have almost disappeared from the market; this compound contained conductive material causing serious losses. Good sockets are now made of high-grade insulating materials, and are so designed that losses are reduced to a minimum.

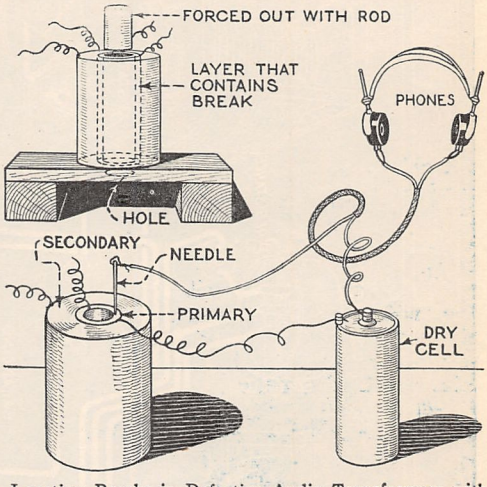
¶Audio-frequency transformers should be mounted at right angles to each other, and 4 to 5 in. apart.

Finding Weak Tubes in Radio Sets

Many fans seem to think that they must be equipped with an accurate tester to locate troublesome tubes in their radio outfits or tubes that are in need of renewal for proper emission. A practical method that has been used for some time, is the following: Obtain a new tube as an extra in case of trouble. Remove the second amplifier tube from its socket and, with the switch cut in, move each tube up one position and note the amplification or tone value it gives. It will not take long to locate the tube which should be reactivated. A tube rejuvenator is the only investment needed, and the cost of an extra tube is of little consequence.

Repairing Audio-Transformers

A defective audio transformer is generally remedied by substituting a new one, although the trouble could be located in the old transformer. It is discarded because the fan has an idea that all the wire in it is ruined, or he does not care to tackle the "miles" of fine wire. However, very few feet of the wire have to be tampered with to locate the break. The trouble in most cases lies in the primary and nine times out of ten not in the winding actually burning out; and as by far the most transformers now in use are the layer-wound paraffin-paper type, it is not difficult to locate the break and repair it. The first thing to do is to remove the core, leaving the primary and secondary windings intact. A simple way to locate the break is to connect one end of a wire to a small needle, and the other end to a dry cell through a pair of headphones, the other post of the dry cell being connected to the winding to be examined. The needle is then slowly forced into the end of the winding; if a click is heard when the point of the needle touches the layer of wire, the wire is unbroken that far. By continuing to push the needle farther in until no click is heard, the exact layer that contains the break can be located. If it happens to be near the outside of the secondary, or the inside of the primary, it can be repaired without much trouble. If it is near the center, it will be necessary to heat the windings so as to soften the paraffin and force these windings apart at the break. This is done as illustrated in the upper left-hand diagram. A small wood platform with a hole in it slightly larger than the defective layer is prepared, and the heated coil is placed over this hole. A cylindrical object that will fit the hole is then placed on the other end of the coil, and force is evenly applied until the windings are telescoped apart.

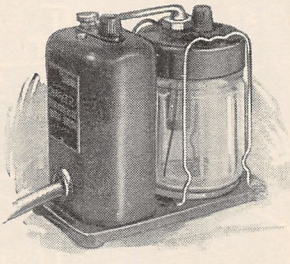


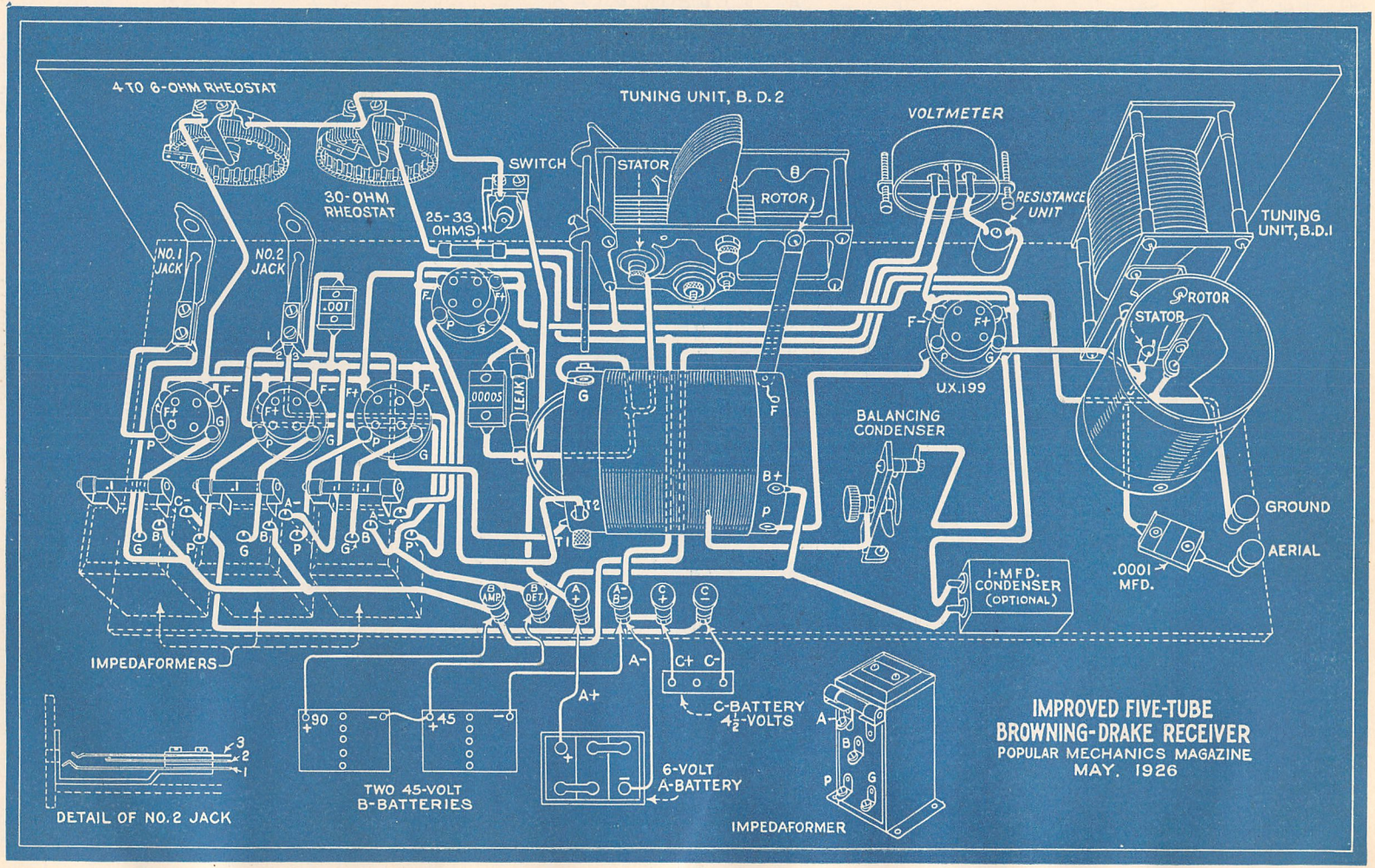
Locating Breaks in Defective Audio Transformers with Headphones in Series with a Dry Cell

When repairing the break, use only rosin for a soldering flux, and in replacing the windings, take care to keep the wire from breaking. If half a layer or so of the coil is lost, it will make no difference in the operation of the transformer. While rebuilding the core, if any trouble is experienced in getting all the laminations in place, try squeezing those that are assembled and then adding more to them.—Watson Brown, Iuka, Miss.

Low-Rate Charger for Continuous A-Battery Supply

A low-rate charger designed for continuous charging over long periods of time is especially designed for dry-cell sets and storage-battery sets having relatively few tubes. The instrument charges both 4 and 6-volt A-batteries at about .5 ampere, and requires very little attention. Operating directions accompany each charger, giving time of operation necessary for the various types of sets. The charger can be so regulated that it can be left on continuous charge, if desired, thus keeping the A-battery up to full charge all the time.




4 TO 6-OHM RHEOSTAT
30-OHM RHEOSTAT
TUNING UNIT, B. D. 2
SWITCH
25-33 OHMS
STATOR
ROTOR
VOLTMETER
RESISTANCE UNIT
TUNING UNIT, B.D.1
NO.1 JACK
NO.2 JACK
.001
.00005
LEAK
ROTOR
STATOR
U.X.199
BALANCING CONDENSER
GROUND
AERIAL
.0001 MFD.
1-MFD. CONDENSER (OPTIONAL)
IMPEDAFORMERS
B AMP
B DET
A+
A-
C+
C-
C+ C-
C-BATTERY 4½-VOLTS
A+
A-
6-VOLT A-BATTERY
90
45
TWO 45-VOLT B-BATTERIES
DETAIL OF NO. 2 JACK
IMPEDAFORMER
IMPROVED FIVE-TUBE
BROWNING-DRAKE RECEIVER
POPULAR MECHANICS MAGAZINE
MAY, 1926

Five-Tube Browning-Drake Receiver of Improved Design

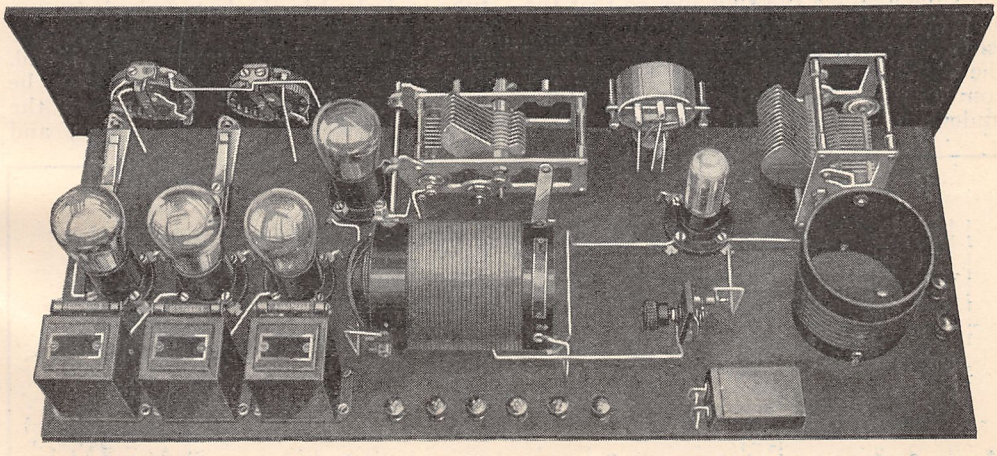
By GLENN H. BROWNING

EVERY broadcast listener desires a radio set which is at the same time sufficiently sensitive to receive distant stations and selective enough to cut out interference and easily separate local stations. The signals received must also have good tone quality. If, combined with these qualities, the receiver is easily built and operated, it is most welcome to the listener. The receiver to be described is selective, sensitive and easily built and, while not perfect, is believed to be a step in the right direction.

The circuit is a combination of old and new ideas, and depends for its efficiency largely on the design of the tuned r.f. transformer used. This 1926 model of the well-known circuit also employs straight-line-frequency condensers, dials of new type, and a very efficient method of impedance-coupled audio amplification. The problems involved were worked out by the writer and Frederick H. Drake, at Cruft laboratory, Harvard university. The particular problem solved was the design of a tuned r.f. transformer, which would give the greatest possible amplification when employed with the tubes now obtainable, the result being, that approximately 90 per cent of the amplification calculated by mathematics was obtained in practice. In this circuit the tuned r.f transformer is used with a regenerative detector, so that one stage of radio amplification suffices for all purposes.

The reader should understand that the purpose of a r.f. amplifier is to build up feeble signals so that distant stations may be received. There is a limit, however, to the sensitivity of any receiver, for noise such as static and "man-made" interference, may be louder than the incoming signals from a very distant station. Then, no matter how sensitive the set may be, only a limited distance can be received before what is known as the static or noise level is reached. Thus, if we have a set which will receive signals up to this level, its sensitivity has reached the practical limit. In the quest for an efficient audio amplifier to combine with the r.f. part of the receiver, laboratory measurements were made on three possible choices, namely, two stages of transformer-coupled audio, three stages resistance-coupled, and three stages of the impedance-coupled type. The latter was finally chosen, for, although it requires three tubes instead of two, only 90 volts of B-battery are needed, and the quality of the received signals is practically perfect. When tested in Popular Mechanics radio laboratory, this receiver had unusually good tone and range.

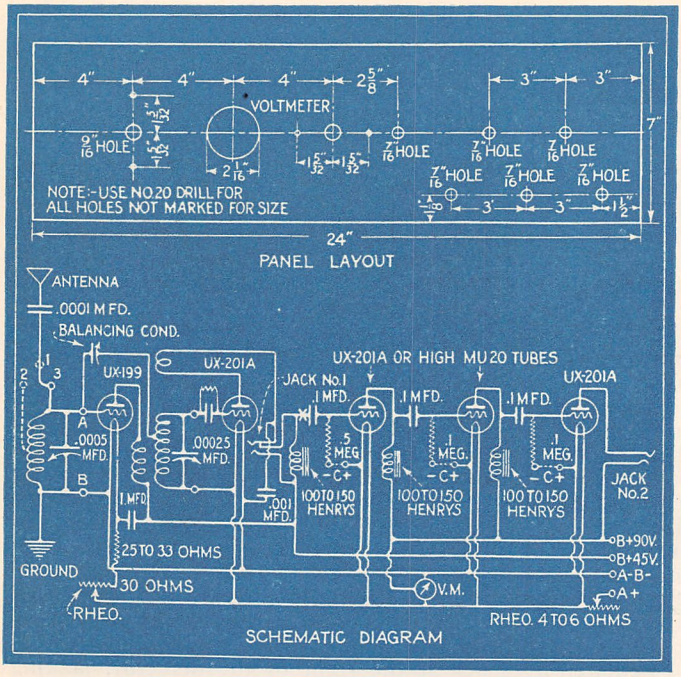
The layout of the receiver is very simple. The UX-199 tube is placed between the two tuning units, and the audio amplifier at the right of the detector, making the leads short, especially those carrying the r.f. currents. The front panel is 3/16 by 7 by 24 in.; the subpanel, 3/16 by 8½ by 23 in. They should be of bakelite or formica, although the subpanel may be of 5/16 in. wood if desired. Mount the instruments on the front panel first, as shown in the front-view photo. Lay out



Rear View of Completed Set, Showing the Method of Running the Wires above the Subpanel

Copyright, 1926, Popular Mechanics Magazine

the instruments on the subpanel as shown in the rear-view photo of the completed instrument and the full-page blueprint diagram. It will be noted that the brackets on the first tuning-unit condenser support one side of the subpanel, while the other end is screwed to the frame of the No. 2 jack. Brass machine screws, or inverted binding posts, can be fitted to support the rear edge of the subpanel. The wiring diagram is given in simple detail on the blueprint page, all of the wiring being shown above the subpanel so that the various leads can be easily traced. When wiring the set, however, it is best to run the leads under the subpanel whenever convenient. The rear-view photo and the underpanel view show the leads both above and below. Black-spaghetti tubing is slipped on the leads where necessary to prevent shorts. The schematic diagram is given for those who prefer it to the simplified wiring diagram.



Above, Front-Panel Drilling Template; Below, Schematic Wiring Diagram

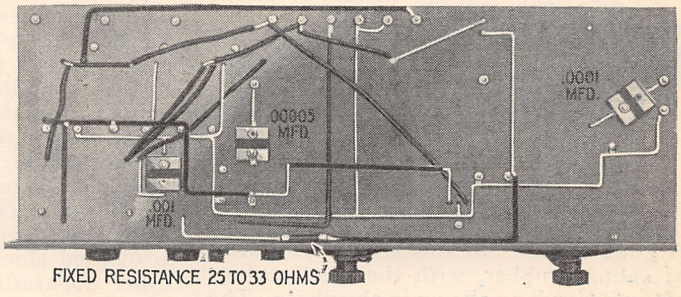
It was found, with either a resistance or impedance amplifier, that the r.f. current entered the a.f. circuit and affected the operation of the receiver slightly, sometimes giving a popping noise in the loud speaker when the tickler coil was advanced too far. This was eliminated with a choke coil placed in series with the .1-mfd. condenser at the point marked X on the schematic diagram, and must be used if any other type of amplifier than that specified in the material list is employed. These impedaformers contain a choke coil and .1-mfd. condenser, and the entire unit is employed in much the same manner as an ordinary a.f. transformer. Connections for the C-battery are shown in the large blueprint diagram. This C-battery is for the last audio stage and can be varied to suit the type of tube used. The new UX-type sockets, suitable for either the 199 or 201A tubes, are used throughout the set. The detector and amplifier tubes are the 201A-type; HI-MU tubes can be used in the amplifier stages if desired. If a power tube is desired in the last stage, it is necessary to provide an extra binding post for the required 135 volts. The 1-mfd. condenser, marked "optional," may be omitted in almost all cases where the leads to the B-battery are short, and

MATERIAL LIST

1 bakelite or formica subpanel, 3-16 by 8½ by 23 in.
1 bakelite or formica panel, 3-16 by 7 by 24 in.
1 National tuning unit, Browning-Drake 1-Type-B.
1 National tuning unit, Browning-Drake 2-Type-B.
1 Yaxley (or similar type) 30-ohm rheostat.
1 Yaxley (or similar type) 6-ohm rheostat.
1 Yaxley (or similar type) switch.
1 Rathbun, General Radio, or X-L, balancing condenser.
5 General Radio UX sockets.
1 Yaxley (or similar type) double-circuit jack.
1 Yaxley (or similar type) single-circuit jack.
1 fixed-resistance unit, 25 to 33 ohms.
1 type 17 double-range Hoyt voltmeter.
1 fixed mica condenser, .0001-mfd.
1 fixed mica condenser, .001-mfd.
1 fixed mica condenser, .00005-mfd.
1 gridleak (try from 5 to 8 meg.).
1 gridleak mounting.
3 National impedaformers (these combine an impedance, .1-mfd. fixed condenser and gridleak).
10 binding posts.
1 fixed condenser, 1 mfd., (optional).
1 UX-199 tube.
4 UX-201A tubes.

These parts, as listed, will cost about $56.75.

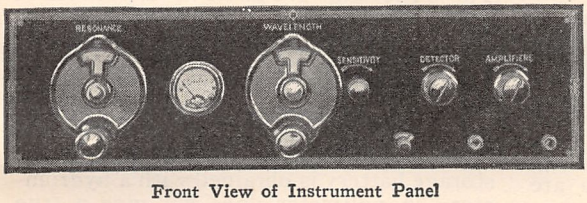
whether or not it helps in balancing the receiver, can only be determined by experimenting. The UX-199 tube is used as a r.f. amplifier, as it is much easier to balance than the 201A-type, and gives approximately the same results. The 33-ohm resistor in series with the filament line reduces the 5 volts across the large tubes to 3 volts for the filament of the small tube, so that the 30-ohm rheostat may be turned full on when maximum signal strength is desired. This rheostat can be used as a volume control so that local-station strength can be reduced as desired.



Under-Subpanel View, Showing the Fixed Condensers in Position

A very short aerial, say, from 10 to 70 ft. including the lead-in, may be erected for the receiver, and the shorter the aerial the better the selectivity. The aerial should be as high as possible, the writer having used a vertical stretch of about 30 ft. with good effect. A short aerial should be connected as shown in the large wiring diagram, and, if the longer aerial is used, a tap should be made from the aerial coil to a separate binding post and the long aerial connected to this post. This arrangement, which is shown at point 2 in the schematic diagram, keeps the dial readings more nearly together.

The set may be adapted to a loop by disconnecting the first coil from the condenser and connecting the loop to points A and B, as shown in the schematic diagram. However, a short aerial has more pick-up, although stations 1,000 miles away have been received under favorable conditions on the loud speaker with a small loop. In fact, the writer has heard, on a friend's set, a station 400 miles away with no antenna connection at all. This is very unusual, however. For extremely sharp tuning it is suggested that the aerial lead be disconnected from the set under crowded conditions in large cities, when local programs are desired. The set is capable of bringing in stations several thousand miles away when properly built and skillfully operated, but the builder should not expect to get distant stations the first night.



Front View of Instrument Panel

When the set has been constructed, the first thing to do is to balance it so that it will not reradiate. Connect the aerial, ground and batteries, and place the tubes in the sockets. Plug in the phones in the first jack, and tune in a local station with the two dials and the rotor, or "tickler" coil. Then turn the 30-ohm rheostat off, leaving the UX-199 tube in the socket; set the balancing condenser so that the local station is heard very faintly if at all. When this condition is reached, rotating the first dial should have very little effect on the signal strength. This is all done with the 30-ohm rheostat turned off. This finishes the operation of balancing the receiver, and the rheostat can be turned completely on again.

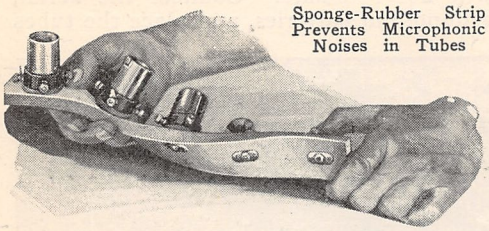
In locating stations for the first time, it is easiest to turn the tickler knob to a point where putting a finger on the stator plates of the second condenser gives a click in the loud speaker, and rotating the dial of this condenser should give a whistle when a station within range is transmitting. Turn back the tickler until the whistle disappears and adjust the aerial tuning condenser to the point where the station is loudest.

Blueprints for this set, including full-size drilling template and enlarged wiring diagram, may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago. Include 15 cents to cover postage and packing. Specify blueprint No. 108.

¶By filing the ground wire flat before soldering it to a water pipe, and by soldering the antenna-wire tip into a copper lug, the contact surface of both will be enlarged, and this has been found to increase the efficiency of some sets.

Cushioning Radio Tubes

Microphonic rings are quite common in many radio sets where the sockets are rigidly mounted on the subpanel. Every

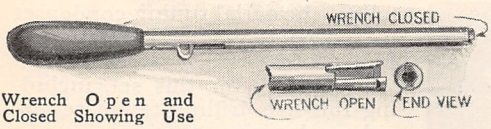


Sponge-Rubber Strip Prevents Microphonic Noises in Tubes

jar in the room is readily transmitted to the tubes and causes distortion in tone. A good remedy for this trouble is a strip of sponge rubber, with the tube sockets mounted on it as shown in the photo. The sockets are fastened by means of screws projecting through both the base and the cushion. The screws are turned up quite tight so that the nuts and washers are pulled up below the underside of the cushion. Glue is then used to fasten the cushion to the baseboard.

Adjustable Radio Socket Wrench

Tightening nuts on the various instruments of a radio set is sometimes rather difficult especially if attempted with a pair of pliers. To overcome this trouble socket wrenches have been put on the market. One, which has been found especially useful, is shown in the illustration. It has adjustable jaws designed to fit many different sizes of nuts. By pulling a thumb adjustment backward the jaws are tightened on the nut, whether this is of the hexagon or the knurled type. The work is done entirely with the hand hold-



Wrench Open and Closed Showing Use

ing the wrench. As it is nearly 10 in. long, it can be used to reach nuts which are otherwise inaccessible.

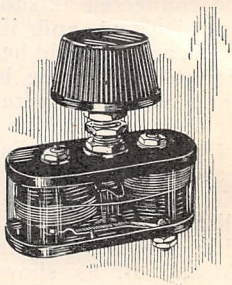
Magnetic Coupling of Parts Prevents Good Reception

The intercoupling of the magnetic fields of the various instruments in the radio receiver is one of the main causes of unstable operation, and distorting music or speech. Faulty wiring, careless soldering and defective instruments also come in for a fair share of the blame.

Other forms of trouble are easily located, but the invisible fields are more difficult to find. These fields are like halos around the coils, condensers and other pieces of apparatus, and must be diverted either by shielding the instruments or by placing them at critical angles, so that the fields will interact as little as possible. This is often a hard matter for the radio builder to do, so instrument designers have produced coils of the toroid, or "doughnut," type and the binocular form in which the field is confined to the coil. Shielded or "canned" coils and condensers are also available. Grounded shields between the tubes and other apparatus also tend to lessen this troublesome intercoupling.

Rheostat for Critical Filament Control

A rheostat of unusual design, for critical filament control, has lately made its appearance on the market. The resistance is varied by winding a wire from a short-circuiting cylinder onto an insulating cylinder, or vice versa. The cylinders have a positive gear drive, and the wire is kept taut by means of a torsion spring. It is claimed that the minimum resistance of the rheostat is less than .2-ohm. Twenty-four complete turns of the knob are necessary for varying the resistance from minimum to maximum, giving a very fine micrometer adjustment. These rheostats are made in resistances of 6, 15 and 30 ohms.



Hydrometer Only Reliable Tester of Storage Battery

The best check on the condition of a storage battery is obtained with a hydrometer. A voltmeter does not give a true reading of the condition of the battery, as a practically dead storage battery will show a 6-volt pressure. A fully charged battery will give a hydrometer (specific-gravity) reading of between 1.300 and 1.285; the half-discharged battery reading 1.200, and a completely dead one 1.100. Never permit the battery reading to fall below 1.200.

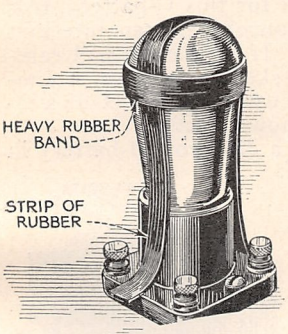
Simple Method of Rejuvenating Tubes

Tubes that have lost their ability to give good reception can be restored almost to their former usefulness by the process of rejuvenation. This consists in applying alternating current to the filament at comparatively high voltage for some seconds, and finishing off with about 8 volts for about ten minutes. If the manufactured unit for this purpose is not available, a homemade device can be rigged up that will accomplish the same results. A bell-ringing transformer of the type having taps for 6, 8 and 14 volts is required; this is connected to the 110-volt a.c. supply line, and the output taken to the filament posts of a tube socket. First determine if your tubes are of the type that can be rejuvenated; if they are of the UV-201A or C-301A types, it is safe to proceed, but do not attempt to rejuvenate other types.

Place the tube in the socket and first apply the full 14 volts for 30 seconds, then keep the tube lighted with 8 volts for ten minutes. These may seem to be excessive voltages, but the tubes will stand them if the transformer is not defective and alternating current is used as directed. It is possible that the tube will burn out under this treatment, but it rarely happens if proper care is taken.

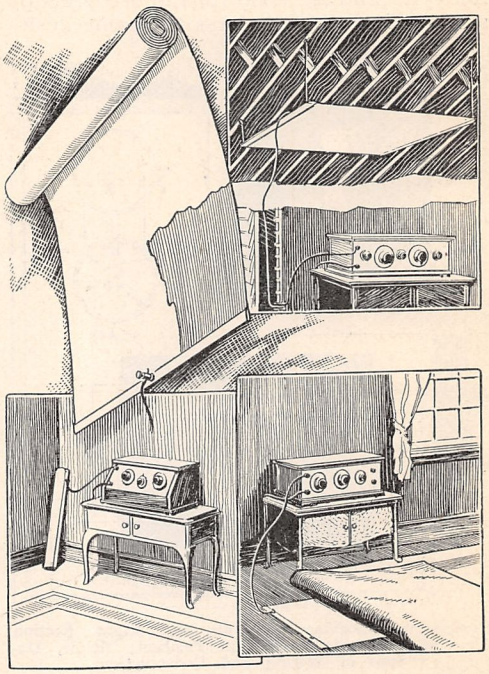
Rubber Bands Help Reduce Microphonic Tube Noises

Owners of radio sets who are troubled with a tube which has become microphonic and produces harsh ringing noises when the set is jarred, can reduce the noises somewhat by using rubber bands as indicated in the sketch. Cut a long, wide and soft rubber band apart, and drape it over the dome of the tube, allowing the ends to trail on the base of the socket. Then stretch a shorter band around the bulge of the tube so it will hold the first band securely in position. This arrangement tends to reduce the vibrations imparted to the glass itself, and will be found a help, especially with a tube that is doing good work otherwise.



Hidden Mat-Type Aerial Saves Space

An efficient mat-type of aerial that takes up very little space is illustrated in the accompanying drawing. The upper-left part shows the aerial partly rolled up, with a section cut away disclosing the wires. The metal strip along the lower edge forms a condenser, and the binding post for the connection to the set is shown in the center of this strip. An aerial of this type can be used in many different ways. It may be suspended in the attic and connected to the aerial post of the set in the usual manner, or spread under the rug, either as an aerial or as a counterpoise. It may also be used rolled up, in which position it is said to be very selective, and as satisfactory as a loop aerial. It is available in 3 by 10-ft. and 3 by 6-ft. sizes. In localities where space is at a premium an aerial of this type minimizes reradiation, and saves roof installations. The fact that it can be hidden is of interest to those who wish to keep as much apparatus as possible out of sight.

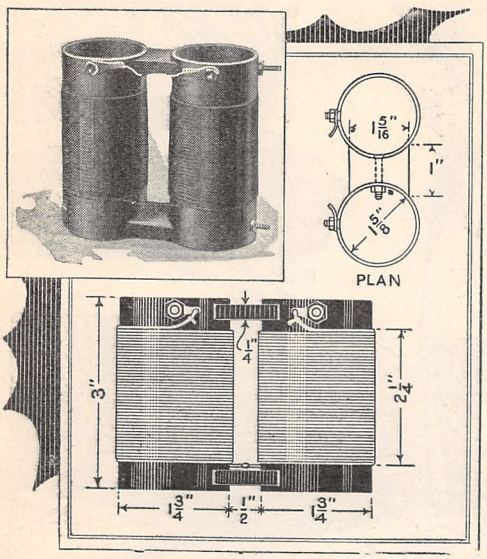


Mat Type of Aerial, Showing How the Wires Are Laid; Inserts Show Various Ways of Using It

¶A new upright B-battery, made specially for portable sets, is 3¼ in. long, 2¾ in. wide, and 5⅝ in. high. It has 50 per cent more capacity than the common portable size and weighs only 2½ pounds.

Building "Binocular" Coils

So-called binocular coils are easier to build than coils of the toroidal or doughnut type, and are ideal for radio-frequency sets. These coils possess the same desirable characteristics, electrically, as the toroidal coils. The insert photo above shows the secondary of a homemade coil of this type. The construction is very simple; two bakelite tubes of 1¾-in. external diameter are used for each coil, the walls being 1/16 in. thick and the length of each tube 3 in. They are wound with No. 22 d.s.c. wire as shown in the lower diagram.



Completed Binocular-Coil Unit, and Right, Section Showing Mounting Screws in Position; Below, Details of Wiring and Construction

When used with .00025-mfd. condensers, 75 turns of wire are wound on each coil, making 150 turns for the pair. The winding occupies 2¼ in. and there are 33 turns to the inch. Of the two coils one is wound clockwise and the other counterclockwise. If .00035-mfd. condensers are used, the number of turns is reduced to 60 for each coil. The winding will occupy 1 13/16 in. on the tube.

After the coils have been wound and the ends of the wire anchored by looping them through small holes, the tubes are assembled, as shown in the lower illustration, by means of two small bakelite spacers, ¼ in. thick, that can be sawed out with a small coping saw. When doing this the bakelite should be clamped to a thin board so that it will not chip. Two small flat-headed brass machine screws finish the assembly. The two coils are then joined as shown in the plan. This completes the secondary of the unit.

The primary is then wound on a slightly smaller tube having an outside diameter of 1½ in. It is space-wound with 29 to 30 turns of No. 32 d.s.c. wire, and then slipped inside one of the pair of secondary coils. Choose the one in which the brass connecting screw is countersunk, so as to permit the smaller tube to slip inside freely.

If desired this primary coil may be moved in or out to obtain a tighter or looser coupling, which is necessary to assure selectivity and prevent oscillation.

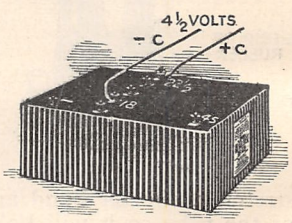
Handle Phones with Care

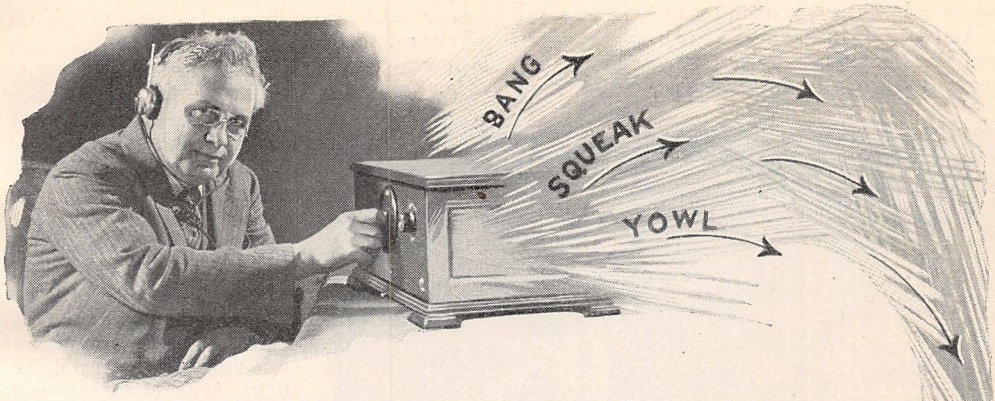
Headphones should be handled as carefully as a fine watch. When correctly built they are delicate instruments and will not stand rough usage. One should never let them drop on the table or floor, nor permit the cords to become twisted, as the tinsel conductor in them is easily broken. See that the terminals are tight, and do not leave phones where they are exposed to dampness, or on a workbench where metal filings are scattered about.

Making the B-Battery Do Double Duty

There are some tricks in the use of batteries with radio receivers which have a decided bearing on operating costs. As is now well known, a C-battery must be used in all sets employing two stages of a.f. amplification, that is, if the B-battery current is to be conserved. When 4½ volts are required for this C-battery, it is not necessary to purchase a separate unit for this purpose. If the reader will carefully inspect the sketch attached, a simple method of securing the effect of a C-battery will be shown clearly.

Most sets have a 22½-volt B-battery in the circuit, as all do not use the heavy-duty batteries. Attach the positive C-lead from the set to the 22½-volt post on the battery and the negative C-lead from the set to the 18½-volt post on the B-battery. It will readily be seen that the 18½-volt post with this arrangement really becomes a negative terminal.—L. H. Georger, Buffalo, N. Y.



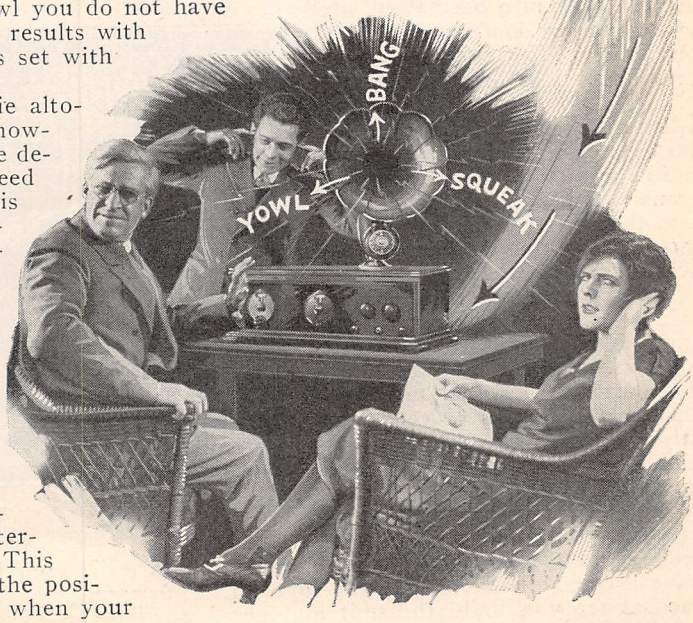


Preventing Oscillation to Improve Radio Reception

By F. L. BRITTIN

GOOD control is necessary in operating any type of radio receiver, and without this good results are impossible. Better control means clearer signals, and makes possible long-distance reception. A set that is "touchy" and inclined to break into squeals is a set that is hard to tune; uncontrollable oscillations of this type really mean that the set has ceased to be a receiver and has become a transmitter. There is a very close relationship between the receiver and transmitter. Some receivers can actually be used as transmitters of code signals by simply substituting a telegraph key for the headphones or horn, and all that is necessary to cover surprising distances with such a transmitter is to increase the plate voltage.

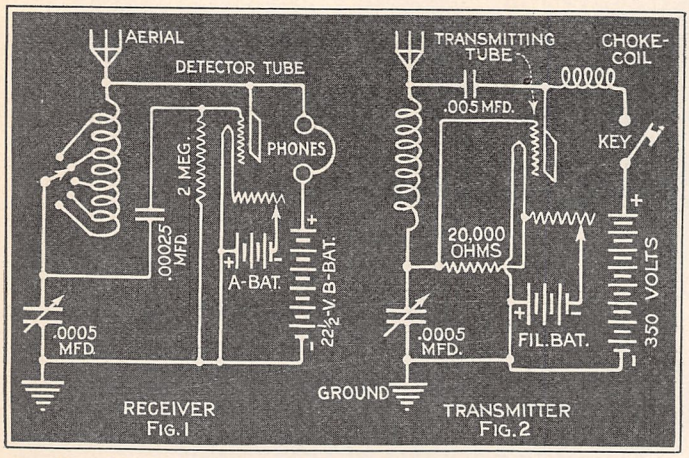
A well-known type of simple receiver is shown in Fig. 1; note the few changes necessary to convert this receiver into an efficient transmitter, as shown in Fig. 2. This simply means that when your set is allowed to squeal and howl you do not have an equal chance for good results with the man who operates his set with greater skill.



The trouble may not lie altogether with the operator, however, as the set may not be designed correctly. It may need better balancing, and this can be done with neutralizing condensers, potentiometers, the addition of a stage or so of r.f. amplification, or by various other methods which add greatly to the tone, selectivity and range of the receiver.

If you do not care to make changes in your set to prevent such a condition, tune the set carefully so as to reduce this interference to a minimum. This can be done by avoiding the position your controls are in when your

set is whistling or oscillating. It is easy to tell when the whistle is caused by your own set, as then, leaving the regeneration control alone and rotating the tuning dial

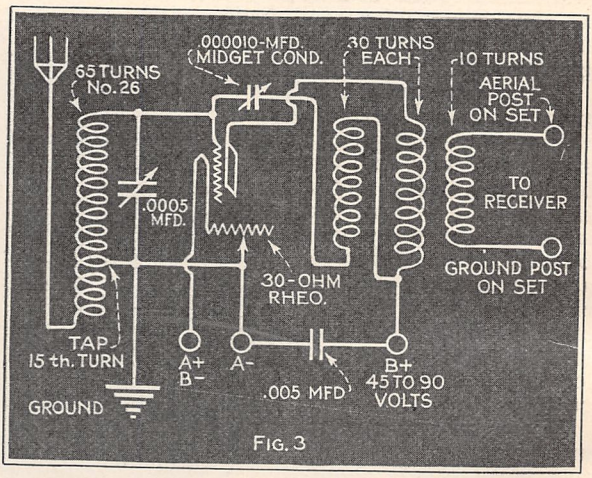


The Close Relationship between Transmitters and Receivers, and the Few Changes Necessary to Turn One into the Other

will cause the whistle to rise and fall in pitch. If two stations are broadcasting on similar wavelengths, they will often cause the set to whistle; if the whistle does not change pitch when the tuning dial is rotated, but merely varies in volume, the trouble is not in your set. Keep the filament supply to the tubes reduced to the lowest point consistent with clear signals and good volume. Turning up the tubes beyond this point will often cause the set to break into oscillation, and also tends to shorten the life of the tubes. Most sets have a control marked either regeneration, tickler, volume or sensitivity; when this control is turned too far over, the set breaks into oscillation and becomes a miniature transmitter sending out waves, and the length of these waves is changed every time you change the position of the tuning dial.

One of the best methods of obtaining better results, and at the same time adding to the range and selectivity of the set is to construct a non-radiating unit that can be attached to almost any type of receiver. A good example of this type of apparatus is the unit shown in Fig. 3. It consists of a few simple coils and condensers and an extra tube, and can be built for about $15. After you have learned that your set is a squealer, the sooner you build the unit and persuade your neighbor who has a similar offender, to do the same, the quicker you will realize how good your set is on distance, if it has a chance to do its best.

The unit can be built up on a small panel and baseboard. The coils are homemade and No. 26 d.c.c wire is used for all. The coil which is connected to the aerial and ground is wound on a 2¾-in. length of 3-in. tubing. Start ½ in. from the end and wind 15 turns, take off a tap and continue the winding for 50 more turns; this completes the first coil. On a 4-in. length of 3-in. tubing, starting ½ in. from the end, wind 30 double turns. To do this, it is necessary to use two lengths of wire, winding them side by side at the same time, making a double coil 60 turns in total length when connected, 30 of which are in each of the two coils. Connect the end turn of one coil to the first turn of the other; at this point note that a lead is taken to the B-positive binding post. On this same tube, from 1 to 1¾ in. out from the double coil, wind the 10-turn coil to be connected to the receiver. Mount these coil units at right angles and space them 2 or 3 in. apart. Mount the 65-turn aerial coil in a horizontal position with the 15-turn end toward the outside edge of the baseboard



A Simple Non-Radiating Unit That Can Be Added to Most Receivers, Improving Both Range and Selectivity

handy to the aerial post. The other unit is mounted in an upright position with the 10-turn coil at the top. The tube socket can be placed between the coils, and the rheostat and condensers are then mounted on the front panel. Arrange the binding posts on either side of this panel in positions handiest to the points to be connected. Fasten the coils to the baseboard with small brass brackets. The small neutralizing condenser can be mounted either on the baseboard or the panel. When connecting this unit to the receiving set, bring additional A-negative and A-positive leads from the corresponding posts on the receiver. It is assumed that the B-battery of the receiver totals from 45 to 90 volts. If the set uses a 22½-volt B-battery only, add more units to bring the total voltage up to from 45 to 90 volts, leaving the detector plate at 22½ as before. If the receiver is of the type using two or more tubes, the 90-volt B-battery is sufficient. Take the 90-volt B lead to the B-positive post on the unit. If there is a previous 90-volt connection on the receiving set, leave it as it is, and take an extra lead from this post to the B-positive post on the unit.

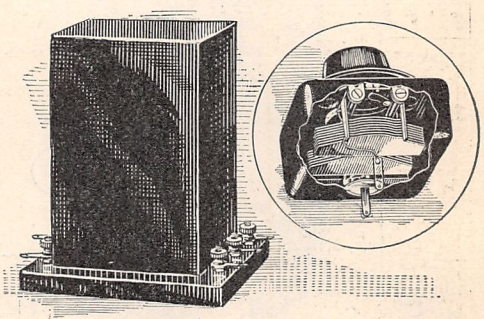
Connect the unit to the aerial and ground and to the aerial and ground posts on the receiver. Now the unit should be balanced. Light the tubes in both the unit and set, turning the tuning condenser of the unit to about 40. Increase the feedback, or volume control of the receiving set, until it oscillates, and tune the receiving set for a signal with its condenser. The signal will come in with the usual whistle; then turn the tuning condenser of the control unit for maximum volume. Vary the setting of the midget condenser until, when turning the tuning condenser of the control unit through the maximum volume of the signal, the whistle is varied in volume but not in pitch. Leave the midget condenser in this position. Tuning is then done with both the large condenser on the unit and the tuning controls on the receiver, adding selectivity and volume to the set.

Blueprints of the unit layout and wiring diagram, may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago. Inclose 15 cents to cover postage and packing. Specify blueprint 109.

¶HOW TO PUT UP AN ATTIC AERIAL is the title of an informative article in the July, 1923, number of the magazine. This will be sent to any address upon receipt of 25 cents.

"Canned" Coils and Condensers

Shielded or "canned" coils and condensers are now on the market, saving

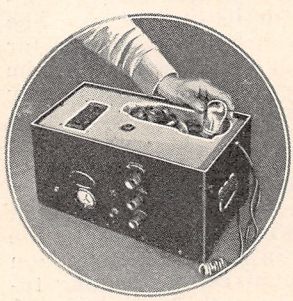


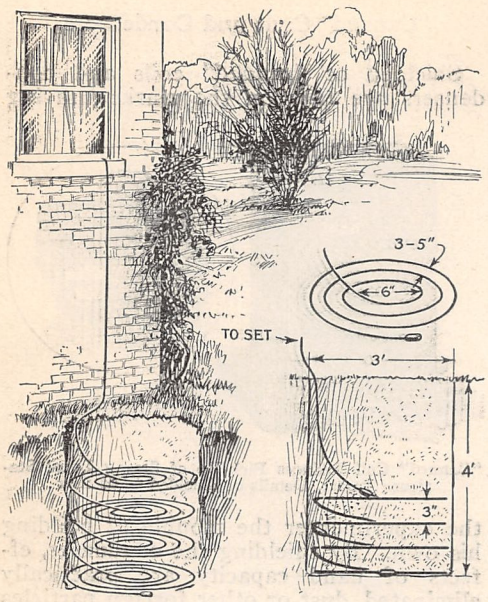
"Canned" Coil Reduces Pick-Up of Strong Local Stations; Insert, Details of Shielded Condenser

the experimenter the trouble of building his own. By shielding the condenser, effects of hand capacity are practically eliminated, dust or other foreign particles cannot accumulate between the plates, interfering with the tuning of the set, and the condenser is protected against magnetic spraying from other instruments. "Canning" of the coils confines their fields and reduces the pick-up of strong local signals by the coils themselves, besides allowing more compact construction, and eliminating the usual critical angle necessary with other r.f. coils. These advantages are especially important when r.f. amplification is employed.

Compact Battery Eliminator

A compact A and B-eliminator is now available. Taps are provided for the various A and B-voltages and the unit is plugged into the 110-volt 60-cycle house-lighting circuit in the same manner as an electric iron, or any similar electrical device. The A-voltage taps are arranged so that tubes of the low or high filament voltage types can be used. When the instrument is connected to the set, the filament switch on the set is left turned on, and the entire installation is turned on and off with a push-pull switch on the front panel.





Details of Underground Antenna Installation, Showing the Method of Coiling Wire and Spacing Coils

Underground Antenna Improves Radio Reception

A specially designed underground antenna is claimed to eliminate all interference by using ground waves instead of the air waves because the former are believed to be practically free from atmospheric disturbances.

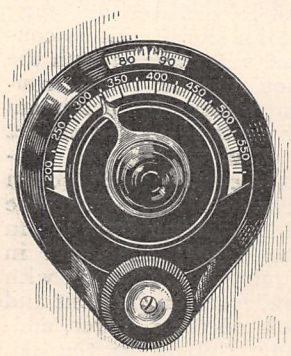
The installation of the ground antenna is very simple. The method shown in the illustration was used by Popular Mechanics radio laboratory with good results and is specified by the manufacturer. The antenna consists of shielded and sheathed wire with especially constructed pick-up coils at the end and center, and is available in either 75 or 100-ft. lengths. The pick-up coils transfer the energy or ground waves by induction, and the sheathing transfers its pick-up of energy by capacity, the shielded lead-in acting as a return for strays.

Locate a suitable spot of ground under the window nearest the radio set, and dig a hole 3 ft. or more deep, 2½ to 3 ft. in diameter. Start with the knob end of the antenna, winding in a clockwise direction to form a flat spiral coil. Working toward the center, keep the turns about 1 in. apart, until the space left in the center is about 6 in. across, as shown in the upper diagram. Cover this coil with about 3 in. of dirt, carrying the wire in a long sweep through this dirt to the side of the hole again; then lay another coil and cover it in the same manner, continuing until four coils are made as shown. The 75-ft. length will leave a balance to be used as a lead-in. Five or six coils can be wound with the 100-ft. antenna. If the cellar floor is not cemented the installation can be made in the basement.

There are two other methods of installing this type of antenna, one, in a straight-line trench from 18 in. to 2 ft. deep, and another in a trench of the same depth, but in the shape of the letter "S." The method illustrated is best, however, as the spiral form is non-directional.

New Dial Gives Readings in Wavelengths

A new dial for locating stations by wavelength readings as well as the usual method is now available. The dial is calibrated both ways from zero, so that either right or left-hand condensers can be used. This reading is shown through the window at the upper edge of the dial; the wavelength divisions are shown on the chart at front, and an adjustable pointer, which can be set to indicate the various wavelengths, also turns with the condenser shaft. An accurate wavelength reading on the chart can be obtained if the condenser and coil used are of suitable types; if not, the chart can be reversed, offering a blank surface for calibration for the condensers and coils used. If desired, the call letters of the stations can be inscribed on the chart. If the coil and condenser specified by the maker are used, a station is tuned in with the condenser plates about halfway out, the wavelength of the station is then looked up, and the large pointer is adjusted with a setscrew to that wavelength on the chart; the straight-line wavelength condenser will then show the corresponding wavelength on the chart.



¶A standard 50-ohm resistance coil, originally supplied with a bulb charger for charging B-batteries, when connected in series with a neutrodyne receiver and a 100-volt storage battery, has been found by a reader to produce increased volume and purer tone.

A Convenient All-Wave Switch

By HUGH G. BERSIE

TO build a single receiver which will cover all required wave bands equally well, necessitates the adoption of some type of tapped coils. An extremely large variable condenser, such as the .001-mfd. type, does not answer because the stations are then crowded close together on the dial, making them hard to separate, even with vernier attachments.

From an electrical point of view, the more satisfactory method of covering these wavelengths is by means of a small variable condenser, such as the .00025 or .00035-mfd. type, these condensers being used in conjunction with tapped coils. This method is illustrated in Fig. 3. When the switch point is set on the tap marked "high," the entire coil is in the circuit, and the higher wavelengths from 600 down to 350 meters are covered as they should be. But when the switch lever is moved to the tap marked "low," only a part of the coil is used and the wave range is reduced to the band from 370 to 150 meters. The small condenser thus takes care of both ranges efficiently, eliminating crowding on the dial and increasing the selectivity of the set.

In the neutrodyne, and other types of tuned r.f. circuits, where it would be necessary to have three sets of switches—one for each coil—the method becomes a little more complicated. In some commercial sets these switches are connected with an insulated rod; but such a combination would be difficult for the home constructor. The same results can be obtained easily with the switch illustrated on the panel directly above the condenser shaft. Three contact points are used, the center one being blank; the switch is mounted on the panel as shown in the section diagram Fig. 4 and in Fig. 2; the switch lever is bent up in the position shown. This switch lever can be made from a bit of spring brass or a phosphor-bronze strip. The method of shifting this switch lever from one

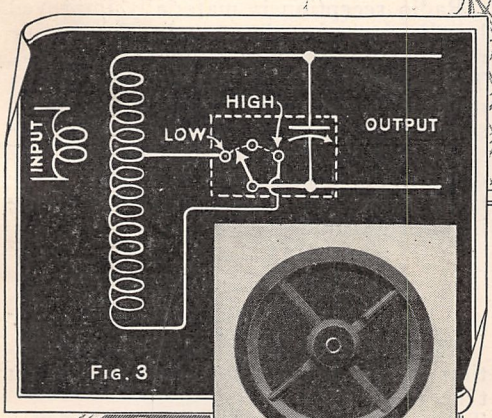
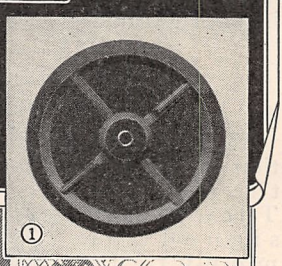


Fig. 3



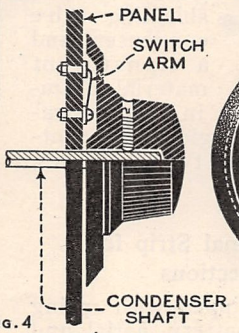


Fig. 4

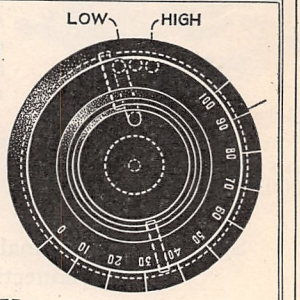
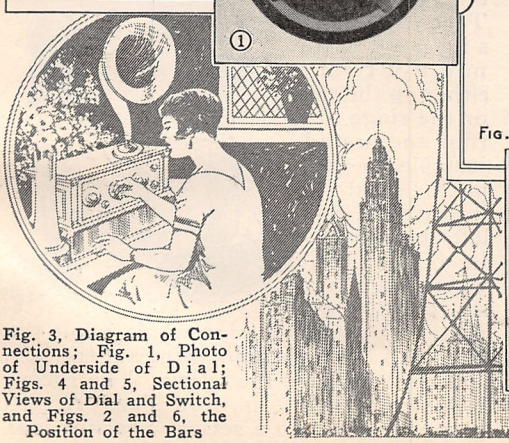
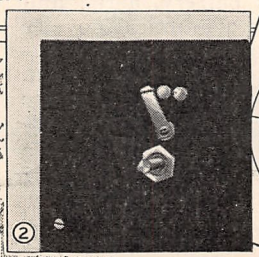


Fig. 5





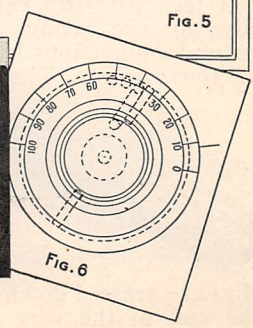


Fig. 6

Fig. 3, Diagram of Connections; Fig. 1, Photo of Underside of Dial; Figs. 4 and 5, Sectional Views of Dial and Switch, and Figs. 2 and 6, the Position of the Bars

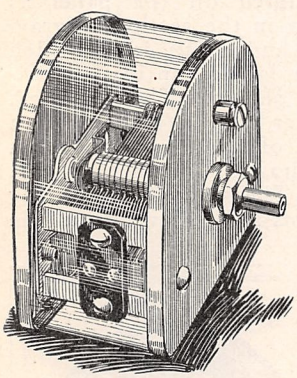
contact to the other is unusual. The underside of the ordinary dial is shown in Fig. 1; it will be noted that the dial is molded with a circular depression that is crossed by the four ridges; two of these have been cut or filed away. The two remaining bars serve to operate the switch as shown in Figs. 5 and 6. Note, in Fig. 5, that the dial is shown just moving by the 90-mark and simultaneously one of the bars is shifting the switch from the low to the high position. Moving the dial back over the portion from 100 to 10 will bring in the high wavelengths. If the operator wishes to go to the lower wave band he will simply move the dial on from 10 to 0, as indicated in Fig. 6. This shifts the lever over from the high to the low position. It is easy to tell by the feel of the dial whether the switch is in the high or low position.

The coil should be tapped for the low switch point approximately 4/10 from the grid end; thus, when the switch is in the low position but 4/10 of the coil will be used. For example, if the entire coil is 60 turns, it should be tapped at the 24th turn from the grid end.

If the dial used does not happen to have bars or ridges, as shown in the photo, small flat-head brass machine screws can be used; these should pass through the dial from the front and project back far enough to operate the switch lever. The middle or blank contact point can be used if the operator desires to have a third point for receiving messages sent on extremely low wavelengths.

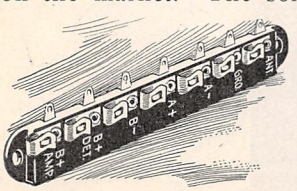
Condenser Inclosed in Dust-Proof Case

A new straight-line frequency condenser inclosed in a dust-proof case is now available, which is claimed to be immune to capacity changes and shorts caused by dust. The case has a metal front and back, which are grounded, shielding the condenser, and a transparent material completes the case as shown in the illustration. The unit is of the single-hole mounting type, and is made in two capacities, .00035 and .0005 mfd.



Spring-Clip Terminal Strip for Quick Connections

A terminal strip equipped with spring clips for the various battery, aerial and ground connections is a practical novelty on the market. The soldering lugs extending from the strip are for the connections to the circuit in the set; to connect the battery and other leads the clips are pressed down with the finger and the end of the wire slipped into place. This is handier than searching for a hole in a binding post or making a loop of the connecting wire.

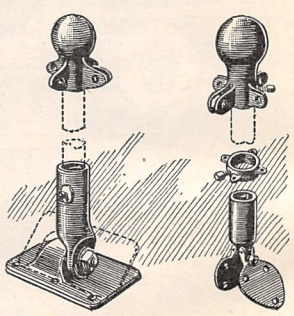


Radio Reception Improved by Double Loud-Speaker Unit

Radio reception is materially improved by the use of a device whereby double reproduction of each sound is obtained. The principle of the device is as old as musical instruments themselves; every sound is reproduced with a double loud-speaking unit, and to give the desired tone quality, the sound from one unit is delayed a fraction of a second, also giving increased volume.

Adjustable Fittings Simplify Aerial Installation

Metal fittings that simplify the installation of roof aerials, have been placed on the market. They are designed for mounting either on the side or the ridge of a roof and are adjustable to any pitch. That illustrated at the left, terminates in a flat plate, which can be set to various angles by means of a screwbolt, while the other has two adjustable wings at the bottom for ridgepole mounting. The socket is made to take ½-in. iron pipe. A slip-ring provided with a setscrew carries four



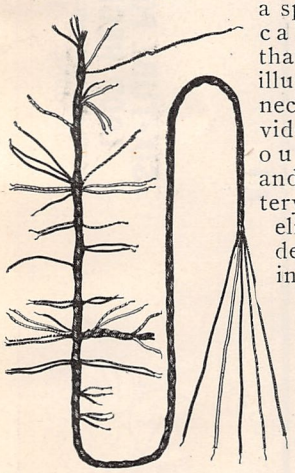
eyelets for fastening the guy wires and the ball top is also provided with flanges for attaching more guy wires, if required.

A Soldering Kink

No matter what the type of soldering flux used, it is a good idea to remove any excess from the joint after it has been completed. Acid fluxes, of course, should never be used on wiring work, but the amateur usually buys his flux from the nearest hardware or radio store, and he may get hold of some that contains a trace of acid, even when it is supposed to be innocuous to wiring. Pipe cleaners, widely used by radio fans for cleaning dust from between condenser plates, may also be pressed into service for removing the excess flux. Double one and dip the doubled end into denatured alcohol, then scrub the joint until all trace of the flux has been removed. An old toothbrush is also an excellent tool for the job.

Wiring Harness for Radio Kits

One of the recent developments in the merchandising of radio kits is the use of a special harness or cable similar to that shown in the illustration. Connections are provided for the various transformers and A and B-battery circuits, thus eliminating soldering and binding posts, as the leads are continued in cable form. A color code is furnished with the kit in order to prevent errors in wiring.

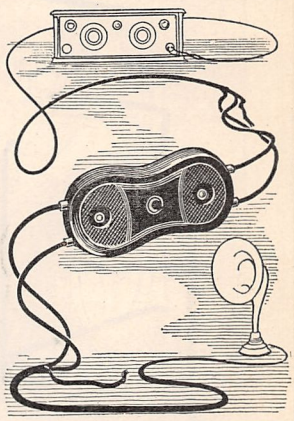


Much Smaller Loops Promised for Future Radio Sets

The loop of the future may be no larger than a man's hand, according to a statement made by a prominent designer of loop sets, so that it can be easily concealed in the set itself. Such a loop will greatly simplify construction and design, and give freer rein to artists who want to create cabinets in unconventional designs. No loss of efficiency is expected with the small loops.

Connecting Plug for Loud-Speaker Extensions

A connecting plug for making quick extensions of the horn cord has lately made its appearance on the market. The horn-cord terminals are plugged in on one side of the unit and the extension-cord terminals in the other side. The device is provided with an automatic release, eliminating the necessity for set-screws. A 20-ft. extension cord is furnished with the double plug, permitting the removal of the horn to an adjoining room if desired.

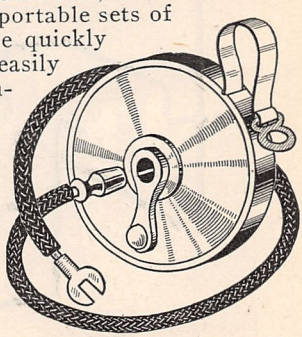


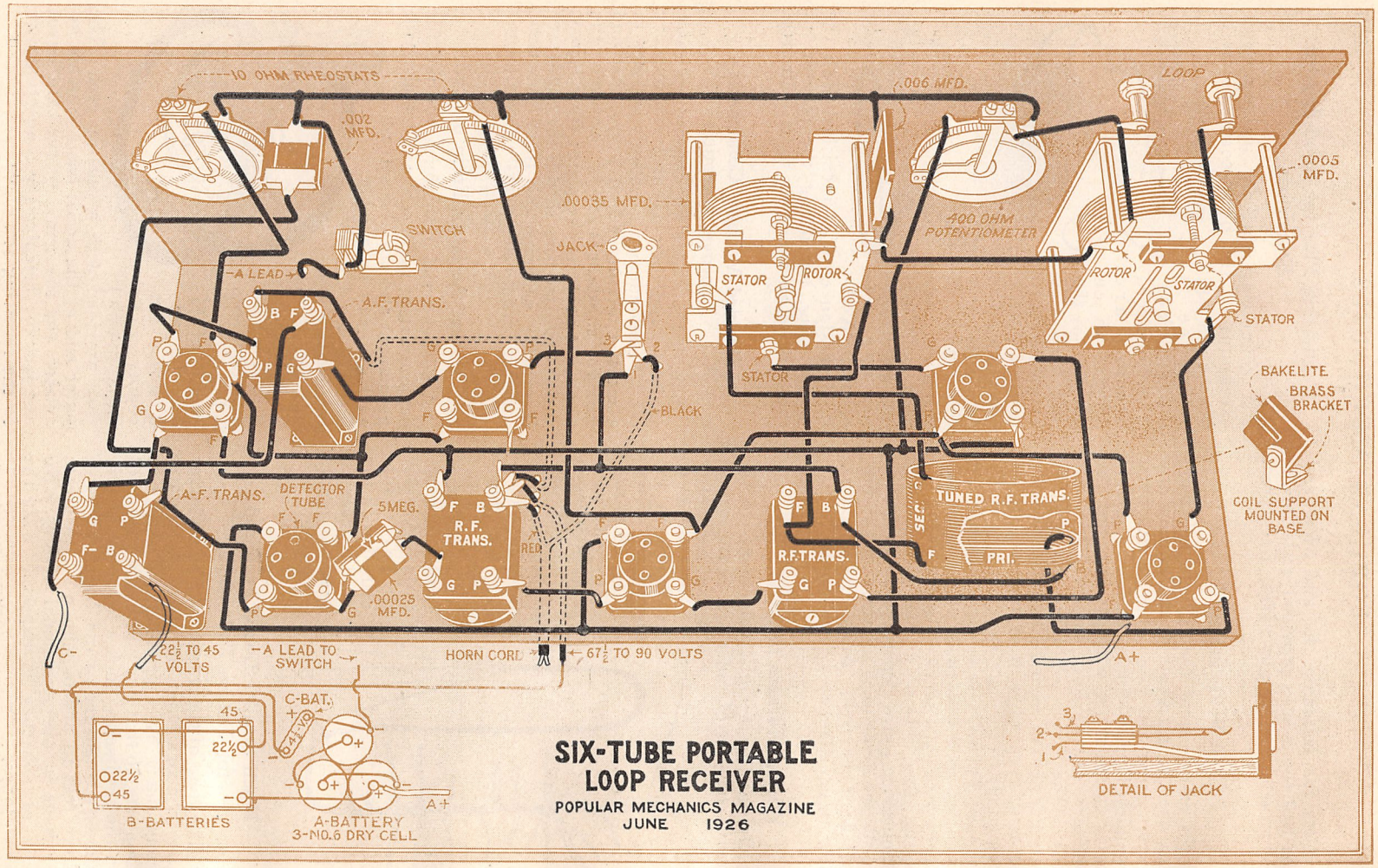
Shielded Variable Condensers Improve Reception

Shielded variable condensers are now available, and their use will improve any set. The condenser is entirely inclosed in a metal container which keeps dust and foreign substances from between the plates. It protects the plates from injury, and at the same time shields the condenser from body capacity and from "magnetic spraying" from other near-by instruments.

Pocket Aerial in Form of Reel

A pocket aerial in the form of a reel for demonstrating radio sets, and for use with permanent and portable sets of all kinds, can be quickly installed and easily removed without the usual tangling of wire. The aerial consists of a 100-ft. length of ¼-in. hard-drawn flat-copper wire in a metal case provided with a take-up reel. The outer end of the aerial has a suitable insulator, and the center of the case serves as a jack for fastening the connecting wire to the receiving set.



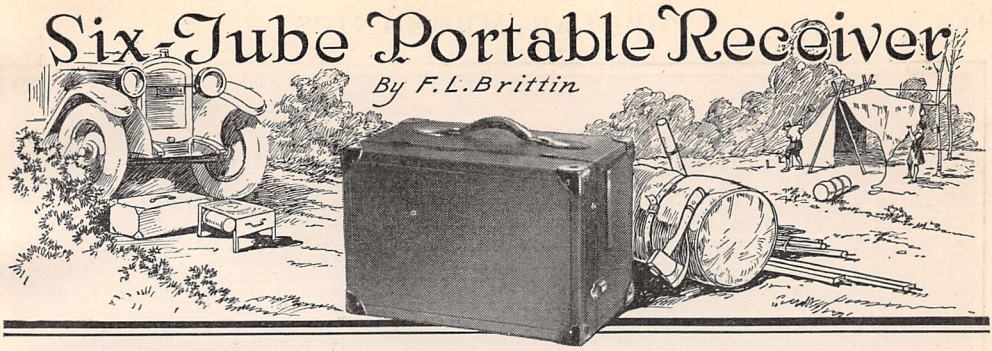


SIX-TUBE PORTABLE LOOP RECEIVER

POPULAR MECHANICS MAGAZINE
JUNE 1926

Six-Tube Portable Receiver

By F. L. Brittin

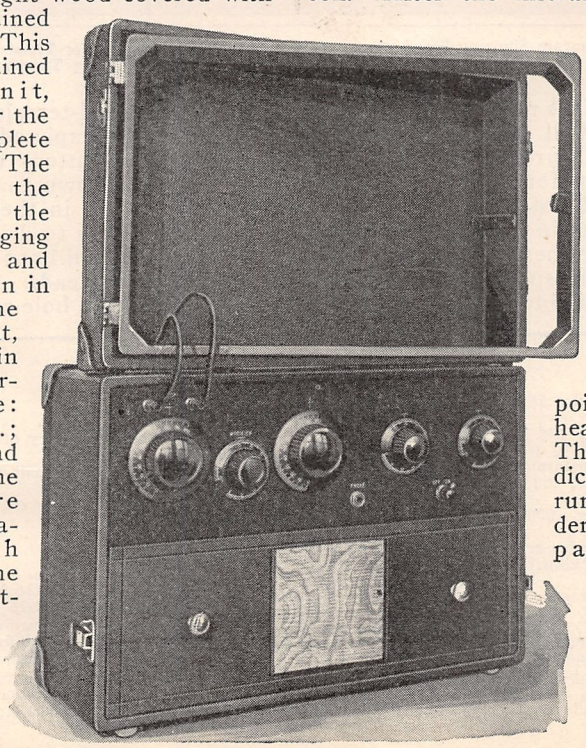


AN exceptionally good six-tube loop receiver, really portable and dependable, is to be described in this article. Its weight, completely equipped with tubes and batteries, is only 32 lb., making it a practical set for the auto tourist and camper, although its appearance is attractive enough not to exclude it from the home. The complete cost to build it is about $105.40, including all accessories. Three No..6 dry cells are used for the A-battery, and as these can be bought at almost any crossroad store or garage, renewal is easy. The B-batteries are sufficiently large to last for several months.

The parts for the instrument itself are all of standard make and can be obtained from any dealer in radio supplies; the case is made of light wood covered with a dull-black grained imitation leather. This case can be obtained as a complete unit, making it easy for the builder to complete the set quickly. The loop is built into the lid of the case in the form of a swinging unit; the horn and batteries, as shown in the rear view of the finished instrument, are all contained in the case. The overall dimensions are: height, 11¾ in.; width 10¼ in. and length 17¼ in. The instruments are mounted as a separate unit, which rests on top of the battery compartment. The results obtained under difficult conditions show the receiver to be very selective, and the range included a log of some 80 stations extending from the east to the west coast, all on the horn. The tone is very good.

In building this set, follow the specifications carefully and use good materials, as poor parts and poor results are closely related.

The front panel should be of some good insulating material especially adapted for radio use, and carefully laid out for the required holes in accordance with the template. Drill the panel from front to back, and mount the instruments. The subpanel used in the model is of light wood, and the instruments are mounted with short wood screws. Note the little insulated bracket for mounting the r.f. coil. After the instruments are all in place, the front panel is fastened to the baseboard with four round-head, nickel-plated wood screws. The set is now ready to wire; the large wiring diagram shows each instrument in place, and the wiring from point to point is in heavy black lines. The dotted lines indicate the wires running down underneath the subpanel and up to their respective terminals. A schematic diagram is given for those who prefer the conventional wiring plan. The wire



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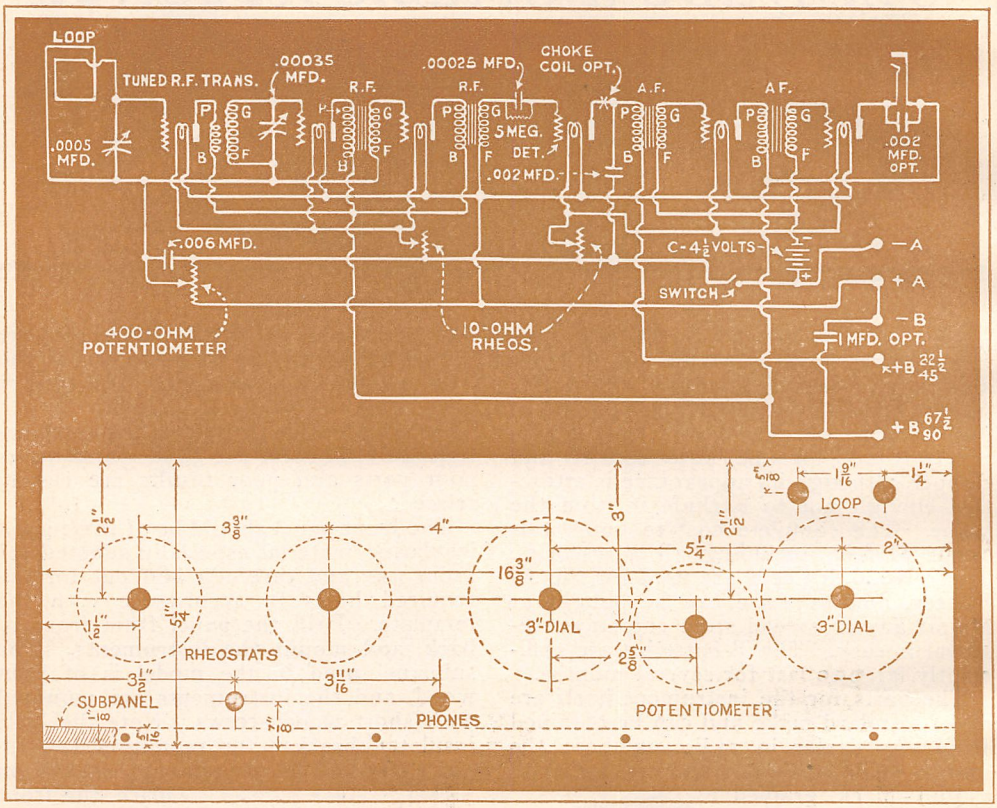


Above, Schematic Diagram Showing Suggestions at the Points Marked "Opt." for Those Who Wish to Experiment Further with the Circuit; Below, Front-Panel Drilling Template

used for the circuit is round tinned-copper busbar, and a small amount of flexible rubber-covered fixture wire where convenient, especially for the flexible leads that are brought down to the battery compartment, as shown in the upper rear-view photo. Room for these few leads is provided by the ⅛-in. space under the subpanel; this space is indicated at the lower edge of the panel-template diagram. After the wiring is completed, place the instrument on the battery compartment, and run the leads down to the A and B-batteries, as shown in the upper photo. It will be necessary to drill holes in the top of the battery and horn compartments for the connecting leads. The horn cord is run up through a hole cut in the subpanel,

MATERIAL LIST

1 front panel, 3-16 by 5¼ by 16⅜ in., (insulated panel material).
1 baseboard, 5-16 by 6½ by 16¼ in.
2 a.f. transformers, 3½ to 1 ratio.
2 Duratran r.f. transformers, 225 to 550 meters.
1 variable condenser, .0005 mfd., with small vernier dial.
1 variable condenser, .00035 mfd., with small vernier dial.
[National DX-condensers used in model, any similar type can be used.]
2 10-ohm rheostats.
1 400-ohm potentiometer.
1 filament switch.
1 fixed condenser, .00025 mfd., with gridleak clips.
1 fixed condenser, .002 mfd.
1 fixed condenser, .006 mfd.
6 X-tube type spring-suspended sockets (Benjamin or similar type).
1 two-circuit jack, Carter No. 102-A or Yaxley No. 2-A type.
2 cord-tip plugs.
2 cord-tip jacks.
1 gridleak, 5-meg. (also try other values from 2 to 5 meg.).
1 C-battery, 4½ volts, small type, (Burgess 5360 or similar type).
2 B-battery units, 45 volts each, (Burgess 5308 or similar type).
3 No. 6 dry cells.
1 loud-speaker unit.
6 UX-199 or CX-299 tubes.
1 fiber or bakelite block, 3-16 by 1 by 1½ in.
1 strip brass for bracket, 1-16 by ½ by 1¾ in.
5 2-ft. lengths, round tinned-copper busbar wire.
10-ft. flexible rubber-covered fixture wire.
5 dozen soldering lugs (long, round-hole type).
2 dozen ½-in. brass wood screws.
4 round-head nickelplated wood screws, 1 in. long.
1 Essential case kit, containing 1 Piper R.F. coil, built-in horn and loop.

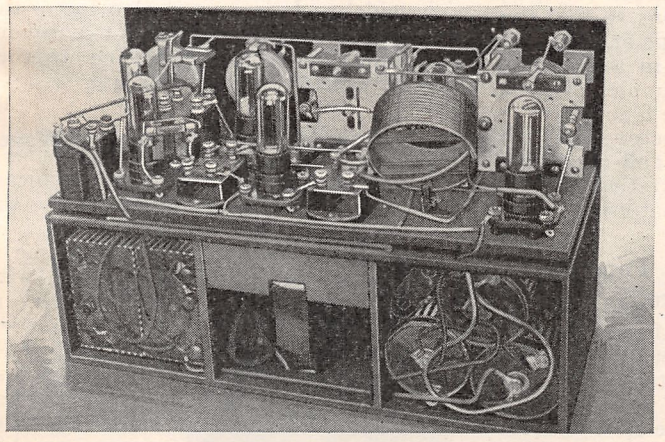
and the terminal on the black horn cord is then soldered to the No. 2 point on the jack, while the red tracer cord is soldered to a lug on the B-post of the second r.f. transformer. Four lugs are mounted on this post, as shown in the large wiring diagram. After the batteries have been connected, place a tube successively in each socket and turn up the rheostat controlling each group of tubes to test the filament circuit; if everything is as it should be, place all of the tubes in the sockets. The completed instrument can now be placed in the case, the loop plugs pushed into the small jacks at the front of the panel, and the receiver is then ready for operation.

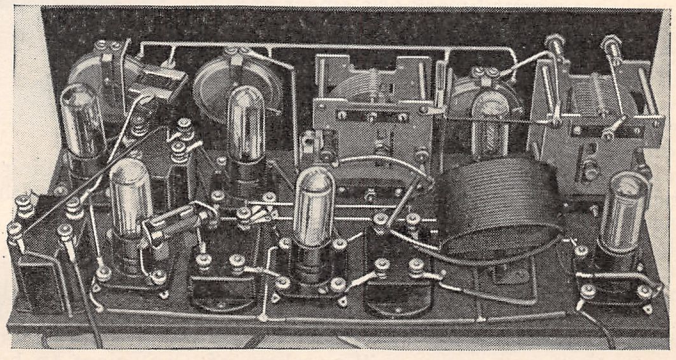
Turn on the filament switch and advance the rheostats, then rotate the dials in step until a station is picked up. Volume control can be obtained with the potentiometer. After some practice it will be noticed that distant stations can often be brought in by adjusting the potentiometer, and local stations on various wavelengths will require different settings on the potentiometer for best reception. Never advance the rheostats farther than necessary to obtain the best results. Phones can be plugged into the jack, automatically cutting out the horn, if desired; in fact, nothing has been overlooked that would add to the efficiency and convenience of the set, making it a really practical portable receiver.

A large blueprint of the wiring diagram and full-size template of the front panel can be obtained from the Radio department of Popular Mechanics Magazine, 200 E. Ontario st., Chicago, for 15 cents to cover cost and mailing. Specify blueprint No. 110.

Crystal Stops Whistling Caused by Station Interference

Radio-transmitting stations equipped with piezo crystals to control oscillation do not cause the whistling interference due to beat frequencies. The bureau of standards states it has tested the applicability of the piezo oscillator as a frequency indicator in broadcast stations and found it useful and satisfactory. More and more stations are adding this device to their equipment and much of the former interference is being eliminated. As compared with the use of a frequency meter, or frequency indicator with a visual indicating device, the piezo-crystal oscillator has two important advantages which are at once apparent. First it is a particularly constant frequency standard, since, when properly designed, the frequency it delivers depends only on mechanical constants of the quartz crystal. Second, the indicator is unaffected by the degree of modulation of the station output, and finally it furnishes an indication of the variation in frequency directly by the pitch of the beat note.

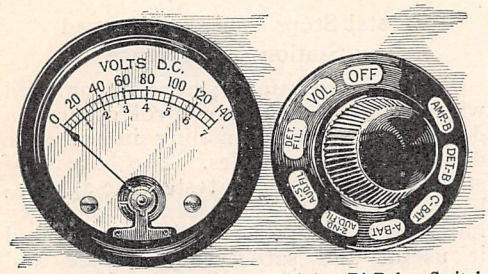




Above, Rear View of the Completed Instrument Mounted on the Battery and Horn Compartment Ready for Placing in the Case; Below, Instrument Unit

Combination Switch and Voltmeter

A combination bi-polar switch and double-scale voltmeter for making a complete check in any radio circuit has lately made its appearance on the market. The switch is in the form of a dial marked with



Left, Double-Scale Voltmeter; Right, Bi-Polar Switch Marked for Positions to Be Checked

the various points to be checked, as shown in the illustration, and is mounted on the front panel in the usual way. A device of this kind insures satisfactory and economical radio operation, making possible the use of tubes at proper filament voltages, and checks battery conditions so that the set can be kept in good shape at all times. If the instrument is used in a five-tube neutrodyne receiver, for example, it is possible to quickly regulate the filament voltages of the r.f. tubes, detector tube, the first and second a.f. tubes, and check the voltage of the A and C-batteries, the detector B and amplifier B-batteries.

The Gridleak and Its Function in the Receiver

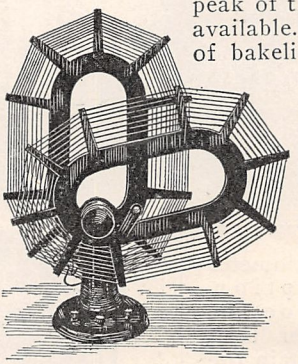
For a number of years after the introduction of the three-element tube, the use of an extremely high resistance in series with the grid of the tube was mostly a matter of hit or miss. Wireless operators found that a pencil mark or a smear of ink connecting the grid leak to the grid element, made a great difference in the sensitivity of the receiver. Eventually manufacturers of radio equipment brought out small high-resistance units for this purpose. The gridleak is growing more and more important. Changes in tube construction, as regards the various voltages used for their operation, different types of filaments, and the numerous circuits, all mean a different value of gridleak for the most efficient operation.

When the specifications call for a 1-meg. or 2-meg. gridleak, the designer means that one or two million ohms of resistance are required to enable the accumulated charge of the incoming signal to leak off the grid of the tubes in time for the grid to be free for the succeeding electrical charge. The carburetor of the automobile is a good illustration of the same action; if the carburetor is fed too much gasoline, the motor is choked, and as a result stops, and similarly, if the gridleak allows too much of a charge to remain on the grid of the tube, it chokes or paralyzes. If the gridleak is of too low a value, decreased sensitivity results; the gridleak may be considered as a valve controlling the amount of electrical energy that the detector tube can efficiently take care of without overload. Any loose connection or minute electrical defect in the grid circuit will cause noisy, crackling reception, because, in the detector tube, the actual transforming of energy from inaudible to audible sound takes place in this tube and is amplified many times in the audio-frequency part of the set.

It will often be found that a gridleak of different value to that specified will better the performance of a receiver. This is not because the designer was wrong in his specification, but because individual tubes vary widely. It is a good plan to try the gridleak specified first, then experiment with other values, to determine whether another will work better or not.

Loop Tunes Receiver to Peak of Wave

A double loop covering the broadcast wavelengths and working only on the peak of the wave, is now available. The frame is of bakelite, wound with phosphor-bronze wire. The loop can be used on any set which has radio-frequency amplification, whether tuned, untuned, reflex or straight. It is claimed to add selectivity and aid in bringing in distant stations, and to work well with regenerative and neutrodyne sets.



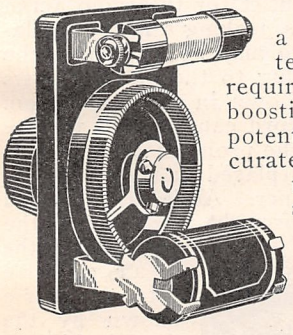
Good, selective reception of radio programs cannot be expected when tuning is done in a careless and jerky manner. A slight touch on one of the dials is often sufficient to bring a station in distinctly or to lose it entirely, and a half-inch turn sometimes covers a dozen stations.

Soldering Headphone Tips

When the headphone tips become loose, which they often do in the course of hard usage, the amateur finds it a difficult job to resolder the ends into the tips. This is because the cords are formed of tinsel, which, owing to the thread woven in it, blackens and chars under the heat of the soldering iron, and makes a poor joint.

Remove the insulation for a length sufficient to enable the broken ends of the cord to be removed, plus the distance necessary to enter the tips for a new joint. Wind the new ends with a little piece of fine copper wire, about No. 35 or 36. Put a very little good paste flux on the wound ends. Now put a drop of solder in the tips, and, keeping the tips hot so that the solder remains liquid, push the ends of the cords into them; then remove the heat and allow the solder to harden. This will make a good, strong joint.

Carborundum Detector Is Self-Contained



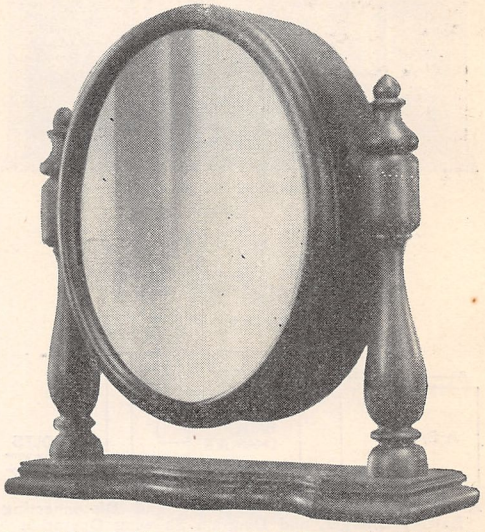
Carborundum is a good stable detector, but as it requires an auxiliary boosting circuit and a potentiometer for accurate adjustment of the biasing voltage, it has not been much used. A new unit of the one-hole mounting type and entirely self-contained overcomes this drawback. It consists of a cartridge containing the carborundum mounted between strong metal clips, a potentiometer, a flashlight cell below in a special mounting clip, and a small fixed condenser, which is connected between the center tap and the slider arm of the potentiometer. The circuit is connected, leaving but the usual input and output terminals.

Connecting Phone Cords

Best results are obtained when the positive wire of the phone cord is connected to the positive side of the B-battery. Some phones are stamped for proper polarity and others have one cord marked with a red tracer indicating the positive side. If they are not marked, try reversing the connections in the plug. The positive side will be indicated by the connection that gives the best results.

Loud Speaker Like Mirror

A combination of radio loud speaker and mirror is a novelty on the market.

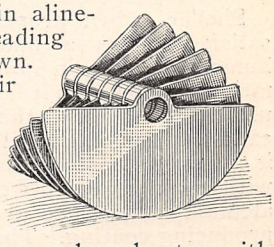


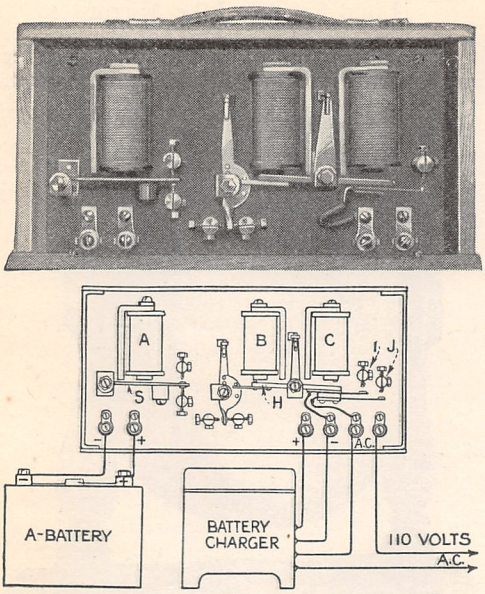
Loud Speaker Combined with Mirror; the Sound Is Deflected through an Opening at the Base of Mirror

The instrument weighs 3 lb., is 10 in. wide and 11 in. high; its appearance, totally unlike any radio horn, will appeal to those who object to the usual type of loud speaker. A sound passage, 17½ in. long, built like the voice passage of the human throat, gradually widens until it forms the mouth at the base of the mirror.

Making Your Condensers Straight-Line

When tuned to the highest broadcasting wave, the variable plates of the condensers on most receiving sets are not usually turned to maximum capacity, and unless they are of the new straight-line type, there is some crowding of the stations on the dial around the lower wave band. The fact that most condensers are of greater capacity than actually needed makes it possible to make them straight-line in effect by loosening the locknut that holds the rotor plates in alinement, and spreading them out as shown. This reduces their capacity so as to give as much vernier effect as possible to low-wave stations, yet allow tuning in of the highest-wave broadcaster with maximum signal strength.—Glen F. Stillwell, Collinsville, Ill.





Automatic Switch for Connecting and Disconnecting Battery Charger, and Diagram Showing Operation

Automatic Switch for A-Battery Charger

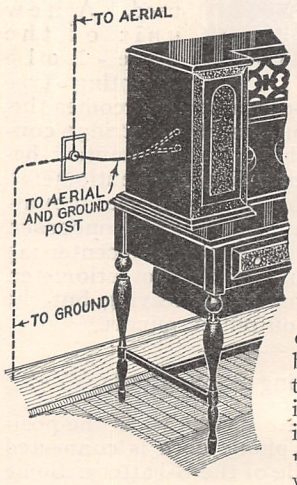
An automatic battery-charger switch that connects and disconnects the charging system for the A-battery, is now available. The instrument is placed between the A-battery and the charger, as illustrated in the diagram. When the voltage of the storage battery falls below the point where further discharge would result in unsatisfactory reception and damage to the battery plates, the armature S drops, closing a circuit that energizes the coil C just long enough to pull the armature H into contact at I and J. When this occurs, the battery is on charge; when the battery is fully charged, the armature S rises, closing a circuit that energizes coil B, pulling up the armature H and breaking contacts I and J. This shuts off the charger.

Binders for Coils

Shellac, when properly used, is quite satisfactory as a binding medium for homemade coils, in spite of the bad reputation under which it labors. The trouble usually has been in the method of application. Shellac should never be used as it comes in the bottle, but must be thinned with about an equal weight or volume of alcohol, in order to avoid a heavy, loss-producing coating. The thinner the shellac the better, provided the coating has the necessary binding qualities, and but one coat should be used, never more. Collodion is also an excellent binder, and it too should be thinned as much as possible, using commercial ether for the purpose. The collodion must be used at once, as the ether evaporates quickly, especially in a warm room. Enameled wire with a single covering of cotton forms a stronger coil than d.c.c. wire, for there is just enough cotton to enable the collodion to bind; with the d.c.c. wire, the same amount of collodion soaks into the cotton covering without binding, and more collodion must be applied, which is not desirable. The best way to apply the binder is to brush it across the wires with a ¾ or 1-in. brush, so that the binder runs in between all the wires. "Flexible" collodion should not be used, as it takes too long to dry. Keep all lights, cigars, etc., away from the collodion and the ether.

Using Wall Socket for Aerial and Ground Leads

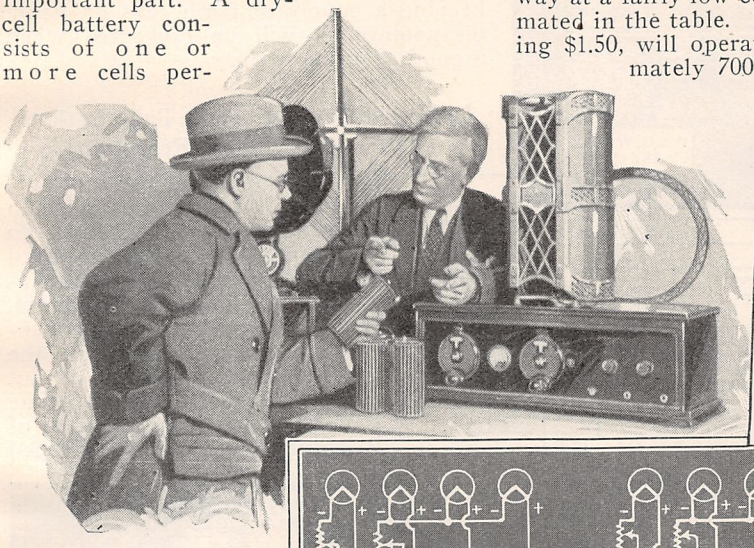
A wall socket of the flush-plate type can be used as an outlet for the radio aerial and ground leads, making a neat installation. Lamp cord may be used from the prongs of the plug to the binding posts on the set, as shown in the illustration. The red tracer cord can be used for the aerial lead, and the prong marked so that the plug will be placed in the socket in the correct manner. Aerial and ground wires that are brought up between the partition to the rear of the plate, are shown by the dotted lines. An installation of this kind does away with unsightly wires, and if necessary to move the set, it is a matter of a moment to disconnect the set by pulling out the plug. There is very little loss in this arrangement, and the writer has tried it out with good results.—Clarence N. Roessl, Chicago, Ill.



¶A 1-TUBE ALL-WAVE RECEIVER with a range of 500 miles, was described in our Aug., 1924, issue, which will be sent to any reader upon receipt of 25 cents.

How to Get the Most from Dry Cells Used for A-Batteries

THE owner of a radio receiver using dry-cell tubes should know something about such cells and how to connect them, for in order to obtain the best results, the employment of the correct number of cells and their proper connection play a most important part. A dry-cell battery consists of one or more cells permanently connected to furnish electrical energy to an electrical circuit. The combination and number differ for each type of tube, and the cells must be connected so that no single one is required to furnish more than .25 amp. The open-circuit "resting" voltage of a dry cell is about 1.5 volts; the carbon rod in the center, from which the current flows to the circuit, is the positive side and is indicated with a plus sign. The zinc can on the outside is the negative pole and is identified with a minus sign. Dry cells cannot be recharged after use like storage batteries and therefore must be connected so as to give the longest possible life.



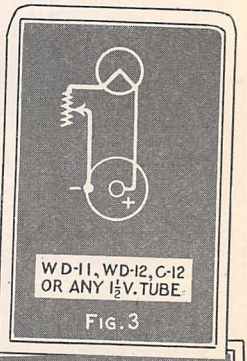


FIG. 3

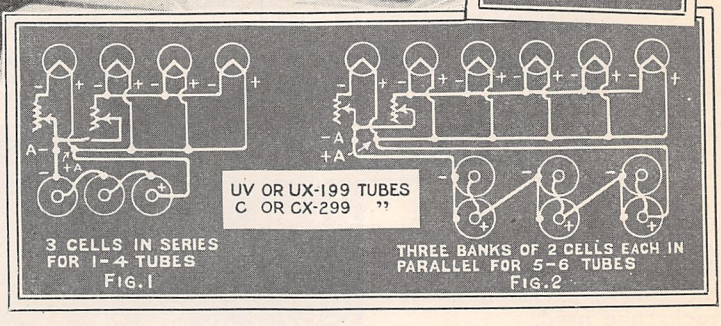


FIG. 1 FIG. 2

Dry-cell tubes are the well-known UV-199, C-299 and similar types that are designed to put a very slight drain on the A-battery. These tubes require but 3 volts for their operation and only draw .06 amp. The new UX-199 and CX-299 tubes are of the same type but have standardized bases, the grid, plate and filament terminals being arranged in the same manner as on the standard 5-volt storage-battery tubes. To obtain the necessary 3 volts, three dry cells are connected in series, as shown in Fig. 1. Connection in series means connecting the center or carbon post of one cell to the zinc or outside post of the next cell. From one to four tubes of this type can be operated in this way at a fairly low cost, which is approximated in the table. Three dry cells, costing $1.50, will operate one tube approximately 700 hours at the stated voltage and amperage, the cost being only 2⅐ mills per hour, and so on, in proportion, for the two, three and four-tube sets. Now if five or six tubes of this type are required, it is necessary to use six dry cells, as shown in Fig. 2, connected in three banks of two cells each in parallel, the three banks being connected in series. The output voltage still remains the same, but the amperage has been raised to accommodate the additional tubes. The first cost is then $3 for the six dry cells, and the cost per operating hour for the five-tube set 1¼ cents and for the six-tube set 1⅔ cents.

The next tubes to be considered are the WD-11, WD-12 and C-12 types; these were our first dry-cell tubes. One dry cell is required for each tube and the tubes are commonly known as the 1½-volt type. Each draws .25 amp., which is the limit for one cell. The connections are shown in Fig. 3 for one tube; Fig. 4 shows how the

cells must be placed in parallel when more than one tube is used, a cell for each tube. The cells being connected in parallel, the .25 amp.-hr. drain will give the same approximate 110 operating hours for any number of tubes, the cost per hour for one tube being 4 4/11 mills and increasing in the same proportion for each tube used.

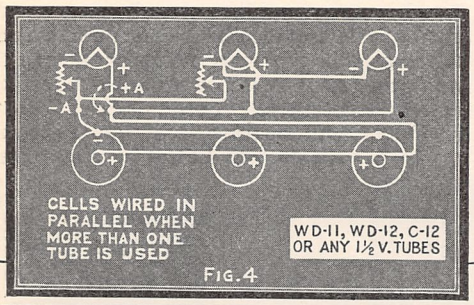


FIG. 4

50¢ DRY CELLS	CONNECTIONS								
	FIG. 1 – 2			FIG. 3 – 4			FIG. 5 – 6		
TYPE OF TUBE	UV OR UX-199 C OR CX-299 DV-3			WD-11 WD-12			UV OR UX-201 A C OR CX-301 A DV-2		
FOR	TUBE AMPS.	HRS.	COST PER HR.	TUBE AMPS.	HRS.	COST PER HR.	TUBE AMPS.	HRS.	COST PER HR.
1 TUBE	0.06	700	2 2/7 MILLS	0.25	110	4 6/11 MILLS	0.25	110	1 9/11 ¢
2 "	0.12	300	½ ¢	0.50	110	9 1/11 MILLS	0.50	110	3 7/11 ¢
3 "	0.18	180	8 1/3 MILLS	0.75	110	1 4/11 ¢			
4 "	0.24	150	1 ¢	1.00	110	1 9/11 ¢			
5 "	0.30	240	1 1/4 ¢	1.25	110	2 3/11 ¢			
6 "	0.36	180	1 2/3 ¢	1.50	110	2 8/11 ¢			

APPROXIMATE HOURS OF SERVICE AND COST PER HOUR OF DRY-CELL A-BATTERIES

The 5-volt or A-tubes are not considered dry-cell tubes, although one or two of them can be operated with a dry-cell A-battery at a fairly reasonable cost, if a storage battery is not available. These tubes also draw .25 amp. per hour, and for the necessary voltage four dry cells connected in series are required for each tube, as shown in Fig. 5. For two tubes, eight cells are required, connected in four banks of two cells in parallel, the four banks being connected in series. The chart shows the operating cost per hour for the two A-tubes has reached 3 7/11 cents, as $4 worth of dry cells are in use; not a very economical method.

It will be well for the user of dry-cell tubes to follow the diagrams carefully with reference to the particular type of tube used in the set in order to obtain maximum efficiency from dry cells. Parallel and series grouping of dry cells, as required for certain tubes, are shown more clearly by these diagrams than can be done by description. The chart is of value to the prospective buyer or builder of a radio set, as he can adjust the operating cost to suit his pocketbook. Knowing the approximate number of operating hours he can expect from his set, the time for renewal can be noted in advance, and by keeping a supply of fresh cells on hand, disappointment will be prevented when a good program is on.

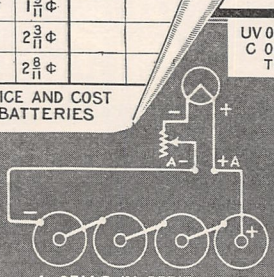


FIG. 5

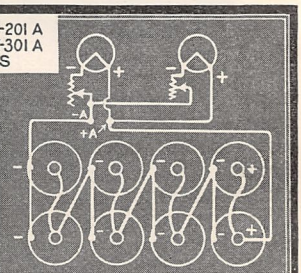


FIG. 6

Defective Connections in Tube Sockets Often Cause Poor Reception

Trouble with the radio receiver can often be traced to the little things that go wrong. The set may be wired correctly and all parts apparently in good condition, but if the tubes are not making perfect contact in the sockets, good results cannot be expected. From the time radio started, a great deal of trouble has been experienced with poor contacts between the tube prongs and the socket springs. Noisy reception, fading signals, and poor volume can usually be traced directly to this defect. Much of this trouble in the past has been due to faulty design, and the manufacturers are making many improvements in sockets that are largely eliminating this form of trouble.

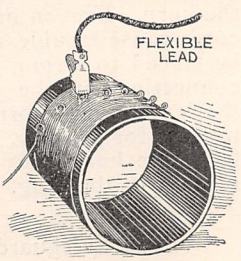
The tube prongs are composed of brass, with a small bit of solder at the tip. Most socket springs are of phosphor bronze, designed to bend upward and make contact against the soldered tip of the tube prongs. The soft solder of the tube-prong tips wears off and soon coats the socket contact with a lead oxide, making a very poor electric contact, and consequently a noisy set. Also, the spring soon loses its resiliency and becomes set, failing to ex-

ert sufficient upward pressure against the prongs of the tubes, and again trouble starts.

Many of the new sockets are provided with side-wiping contact springs that make a good firm contact, gripping the prong tightly. Some have both an end and side contact, making doubly sure of good contact. Where the socket is suspected, bend the socket springs so that they make good contact with the tube prongs, taking care first to disconnect the batteries from the set. Clean off all the discoloration from the tube prongs, both sides and bottom, with fine sandpaper, and clean the wiping surfaces of the socket springs in the same way.

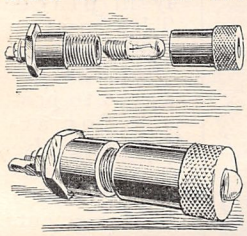
Single Lead Avoids Dead-End Losses

A simple and direct method of connecting a tuning coil so as to eliminate dead-end losses, is illustrated in the drawing. A single flexible lead is used and is fitted with a clip at its free end. Direct connection is easily made to any tap by means of the clip. This makes effective use of the working portion of the coil, as no losses are introduced through unused wire and repeated connections. The taps are readily accessible.



Tube-Protector Lamp Warns of Excessive Current

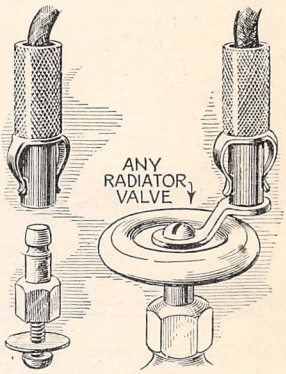
A small signal lamp which is designed to warn the operator whenever excessive drain of current occurs from the B-battery is now on the market. When too much current flows from the battery, the bulb lights up, indicating that something is wrong in the set. It is made for panel mounting and can be used in any type of battery-operated radio receiver; the upper illustration shows the cap removed for mounting.



¶Volume and selectivity can be greatly improved in any receiving set by placing a variometer in the ground lead, not shunting it, but connecting it in series. This will also serve fairly as a wave trap and will not change the wavelength of the set.

Solderless Snap Terminals for Quick Connections

Snap terminals that require no soldering are now available. These connectors make positive contact and are recommended for panel, ground and battery leads. The method of obtaining a quick ground on a radiator valve is shown in the illustration. This special stud is tapped and furnished with an 8-32 screw and washer; the same base stud fits all B-batteries equipped with screw posts.

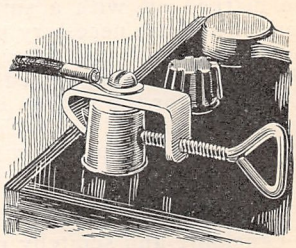


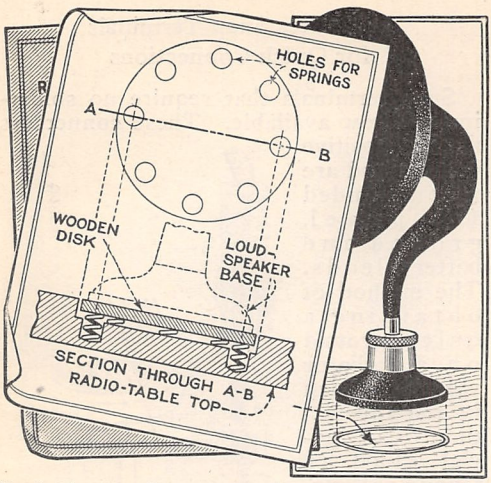
Winding R.F. Transformers

The winding of r.f. transformers is not difficult, but the instrument must be designed for the capacity of the variable condenser used with it. For a .0005-mfd. condenser the primary winding consists of 10 turns of No. 32 d.c.c. or d.s.c. wire wound on one end of a bakelite tube, 3½ in. long and 3 in. in diameter. The starting end will be the positive B and the other end the P-terminal. Leave a ½-in. space for the secondary and wind 42 turns of No. 24 d.c.c. wire; the start will be the F-terminal and the end the G-terminal.

Handy Clamp Fits All Battery Terminals

A clamp that will fit all types of storage-battery terminals is a new utility. The clamp makes a positive contact by means of a thumbscrew on any type of terminal, such as batteries that are not provided with wingnuts for fastening the leads and the auto-type of battery in common use. These latter have smooth terminals, as shown in the illustration, with which a good and easily removable connection could scarcely be made except by means of a clamp.





Shock-Absorbing Mounting for Loud Speaker in Table Top and Details of Construction

Shock Absorber Mounting for Loud Speaker

All radio fans who take pride in the type of equipment they employ will appreciate the shock-absorbing mounting for the loud speaker illustrated herewith. Any radio cabinet or table can be equipped with it at very small cost. The results in better tone quality, free from the usual singing vibrations present in most horns when used on the same table with the set, will amply repay the fan for the slight amount of work necessary.

A wooden disk is supported on eight small brass springs which can be purchased at any hardware store. These springs are held in an upright position in the eight holes countersunk in the recess, as shown in the sectional diagram. The wood disk should be slightly larger than the base of the horn; the thickness of the disk will depend on the depth of the recess which should be just sufficient to bring the top of the disk flush with the top of the table. The diameter of the recess should be slightly larger than the diameter of the wooden disk; a circle can be marked off with a suitable gouge or scriber and the necessary portion chiseled out carefully so as to keep a clean edge that can be sandpapered off smoothly. The holes for the springs can be countersunk with a wood bit of the proper diameter to take the springs snugly.

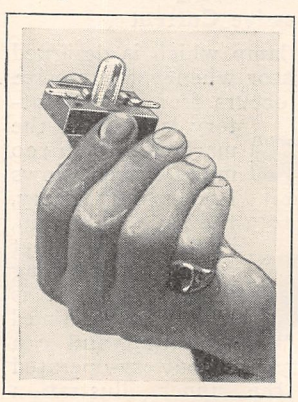
Locating Noises in Receiver

Crackling and scratchy noises from the loud speaker are generally easy to locate and remedy. The commonest and simplest method of doing this is to proceed by elimination. Determine first if the noise is due to an outside source by disconnecting the aerial from the set; if the noise stops immediately, the trouble is not in the set but may be caused by some electrical disturbance in the neighborhood. Another good test is to throw the set out of resonance; if it is of the common tuned r.f. type, set one dial at 0, the next one at 50, and the third one at 100. If the noise still persists, look for trouble in the set or batteries. To test for noise in the batteries, use a pair of headphones, placing one tip on the negative terminal and the other on the positive, getting a sharp click, then no noise whatever. If there is a swishing and crackling sound the battery is probably defective, and should be replaced with a new one.

Noise in the set is often caused by poor contact of the tubes in the socket, dirty prongs and clips often preventing good reception and causing crackling sounds in the horn. Broken or frayed loud-speaker cords cause trouble, and poor results may be traced to wrong polarity of the horn connections in the jack. Try reversing the leads in the horn plug, or get a plug marked for polarity. The red tracer cord from the horn goes to the positive connection in the plug.

Fuse Safeguards Radio Tubes

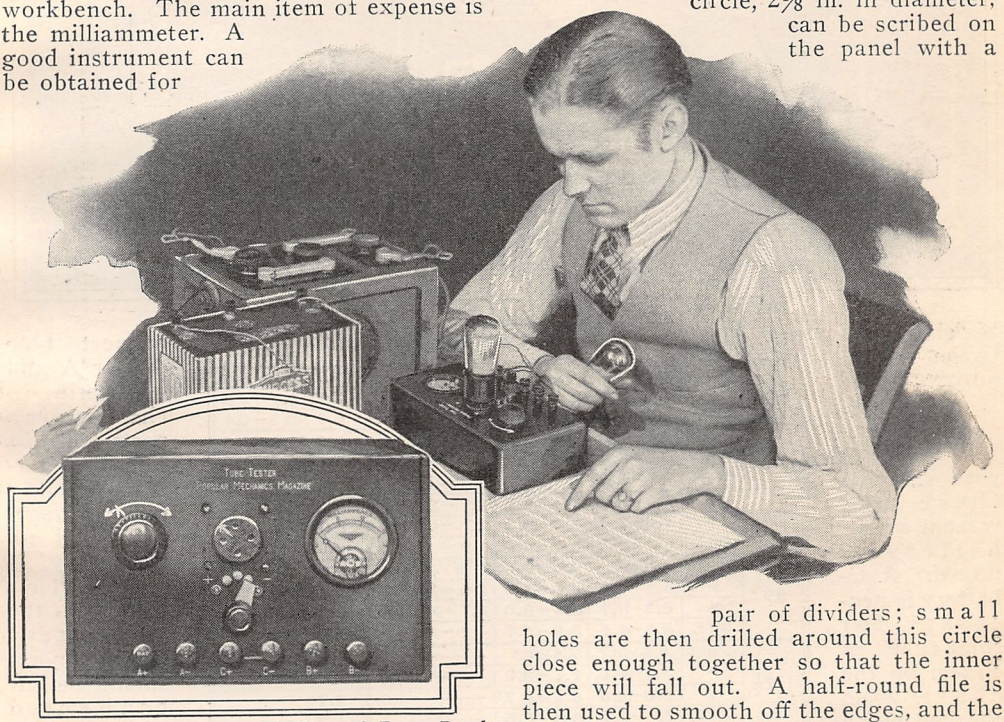
A fuse designed to prevent the burning out of radio tubes due to excessive current has appeared on the market in a handy form. The base is of insulating material and has two spring clips to hold the fuse firmly in place. The outer ends of these clips are designed to provide for attaching the wires by soldering. The fuse element, contained in a glass tube, is always visible and spring terminals engage securely with the clips in the fuse base. The illustration shows the fuse and block ready to install in the circuit. As there is always a chance of accidentally shorting the high-voltage B-battery into the A-battery and burning out the tubes, the fuse safeguards against such losses.



Building a Simple Tube Tester

By HARRY P. LETTON

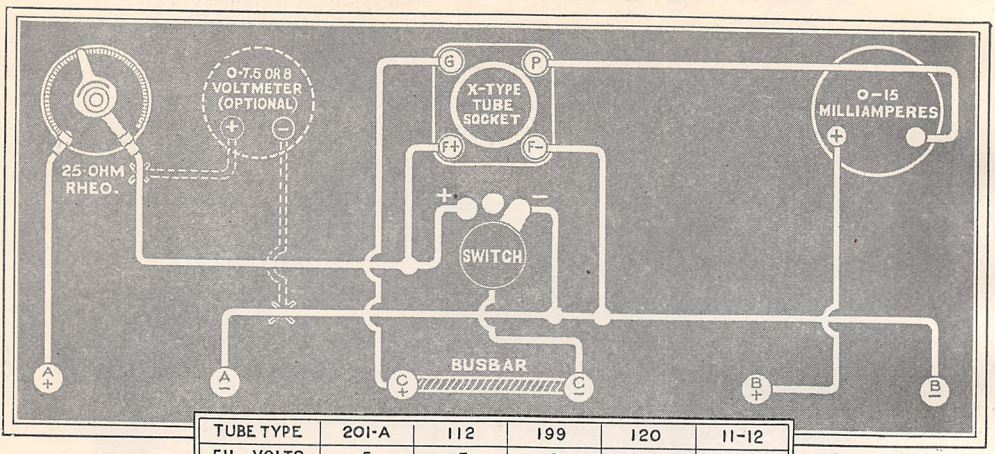
AN efficient and very simple tube tester can be built from odds and ends about the average radio experimenter's workbench. The main item of expense is the milliammeter. A good instrument can be obtained for about $7. The other parts required are very simple and inexpensive; a 25-ohm rheostat, tube socket of the new X-type, six binding posts, switch lever and three contact points with stops. The panel can be of any insulating material, the size of this panel depending on the size of the case used. The case used in the model was an ordinary cigar box, 2¼ in. deep and of the size ordinarily used for 50 cigars. The lid was removed and the box scraped and sanded to a smooth surface; it was then stained a mahogany color, and varnished. It may be finished to suit the individual builder. The drilling template for the panel is given; the exact size of the holes will depend on the type of parts used.



Tube Tester in Use; Detailed View of Front Panel Shown in Insert

The instruments are then mounted on the panel in the positions shown in the front-view photo of the finished instrument. The X-type tube socket used in the model was of the spring-suspended variety; the upper part to which the terminal connections are fastened was removed from the base, and mounted directly on the panel. However, any type of X-socket can be used and mounted in the usual manner. Drilling the hole for the milliammeter is not so easy, but a circle, 2⅛ in. in diameter, can be scribed on the panel with a pair of dividers; small holes are then drilled around this circle close enough together so that the inner piece will fall out. A half-round file is then used to smooth off the edges, and the milliammeter fitted in place. The switch lever and contact points are then mounted as shown, and the outside contact points marked positive and negative exactly as shown on the template. The center point is dead. Binding posts with engraved tops can be obtained so that it will not be necessary to mark their positions on the panel.

The tester is now ready for wiring. The wiring diagram shows each instrument and the wires running to them will be found above the chart. This wiring is shown just as you would see it if the panel was transparent; No. 14 round, tinned-copper busbar wire is used for the circuit. All connections are soldered to lugs mounted on the terminals of the various instruments. The voltmeter, shown in the dotted lines, is optional and may be omitted to keep down the cost. It is important if exact tests on the rated filament voltage of the tubes are required, but for ordinary testing, the rheostat can be turned up to the usual tube brilliancy, or saturation point, as shown on the milliammeter when the switch lever is placed on the negative contact point. The bus-



TUBE TYPE		201-A	112	199	120	11-12
FIL. VOLTS		5	5	3	3	1.1
"B" VOLTS	SWITCH	MILLIAMMETER READINGS				
22½	−	0.3 – 0.5	0.7 – 1.3	0.2 – 0.4	0.9 – 1.3	0.2 – 0.4
	+	1.7 – 2.3	5.2 – 7.3	0.7 – 1.1	1.7 – 2.3	0.4 – 0.8
	DIFF.	1.4 – 1.8	4.5 – 6.0	0.5 – 0.7	0.8 – 1.0	0.2 – 0.4
45	−	1.3 – 1.6	3.0 – 3.6	1.2 – 1.5	3.4 – 4.0	1.2 – 1.5
	+	4.3 – 5.2	10.0 – 12.2	2.0 – 2.7	4.5 – 5.5	1.5 – 2.0
	DIFF.	3.0 – 3.6	7.0 – 8.6	0.8 – 1.2	1.1 – 1.5	0.3 – 0.5
67½	−	2.6 – 3.8	5.4 – 6.7	2.7 – 3.0	7.2 – 8.0	2.5 – 3.8
	+	6.0 – 7.8	13.8 – 16.5	3.7 – 4.4	8.4 – 9.7	2.8 – 4.3
	DIFF.	3.4 – 4.0	8.4 – 9.8	1.0 – 1.4	1.2 – 1.7	0.3 – 0.5
90	"C" BAT.	NONE	6.0-VOLT	4.5 VOLT	7.5 VOLT	4.5 VOLT
	−	4.4 – 6.5	2.0 – 3.0	2.5 – 3.0	7.5 – 8.5	2.3 – 2.8
	+	8.2 – 11.1	5.6 – 8.0	3.7 – 4.7	8.6 – 10.1	2.6 – 3.3
	DIFF.	3.8 – 4.6	3.6 – 5.0	1.2 – 1.7	1.1 – 1.6	0.3 – 0.5
112½	"C" BAT.	4.5 VOLT	7.5 VOLT	———	15.0 VOLT	———
	−	3.6 – 4.8	2.2 – 3.2	———	7.3 – 8.0	———
	+	9.0 – 10.5	6.7 – 8.7	———	8.5 – 9.7	———
	DIFF.	5.4 – 5.7	4.5 – 5.5	———	1.2 – 1.7	———
135	"C" BAT.	———	9.0 VOLT	———	22.5 VOLT	———
	−	———	5.0 – 6.0	———	6.5 – 7.5	———
	+	———	12.2 – 14.5	———	7.9 – 9.3	———
	DIFF.	———	7.2 – 8.5	———	1.4 – 1.8	———

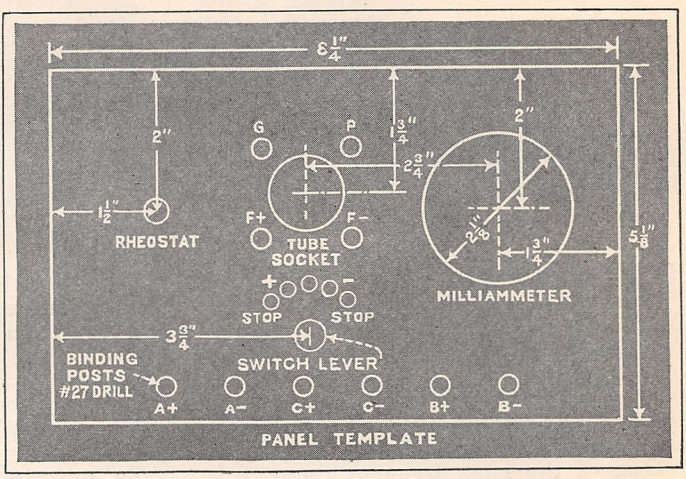
TUBE-TESTER CHART

bar shown between the C-positive and C-negative posts is merely a piece of wire shorting these posts when no C-battery is used. A C-battery is necessary for some tubes, as shown on the chart, when checked with certain B-battery voltages. It is a good idea to check the tubes under the same battery conditions existing in the set in which they are used; however, a 45-volt B-battery and A-battery of suitable size for the tubes to be checked are sufficient for ordinary tests with tubes of the 201A and 199-types.

The operation of a vacuum tube is dependent upon the controlling effect of changes in grid potential on the plate current. The filament may light as usual, yet certain defects may exist in the tube. The controlling effect of the grid may also be absent, and there may be internal shorts in the tube. If a tube is normal, a definite amount of current will flow from the B-battery to the tube when the tube is turned up to normal voltage. When the grid potential is changed a given amount, the plate current should change to another value, and the relative value of this change largely determines the value of the tube. When testing tubes with this instrument, connect the proper A and B-batteries to the binding posts, being careful to observe the correct connections. If no C-battery is specified on the chart, the C-battery binding posts should be left connected with the busbar wire. If a C-battery is specified, take out this short-circuiting connection and put in the proper C-battery, observing the correct polarity. The C-battery enables the tester to be used on a greater range of voltages, and with the newer type of tubes. Turn the rheostat to the off point, and place the tube to be tested in the socket. The X-type socket will have two large holes for the filament prongs of the tube.

If the tube being tested is of the old type having the small prongs, determine which are the filament prongs before putting the tube in the socket. The metal pin on the side of the tube base is usually on the grid and plate side of the tube. If in doubt, place the tube in an extra socket to determine the position of the terminals and mark them on the base of the tube. With the old type of 199-tube it will be necessary to use an adapter. Place the switch lever on the negative contact point and turn up the rheostat to the normal

voltage, or point of saturation, as shown by the milliammeter reading. Take this reading, which indicates the value of the plate current in milliamperes when the grid is connected to the negative end of the filament. Then switch the lever over to the positive contact. This shifts the grid from the negative to the positive filament, and the plate current will rise to another value. The greater this change in plate current for a given grid-value change, the higher the mutual conductance of the tube, and the better it is. These readings may be considerably higher than those shown in the chart; if so, good, but they should not be lower. Some tubes will be found to give much higher plate-changes than others.



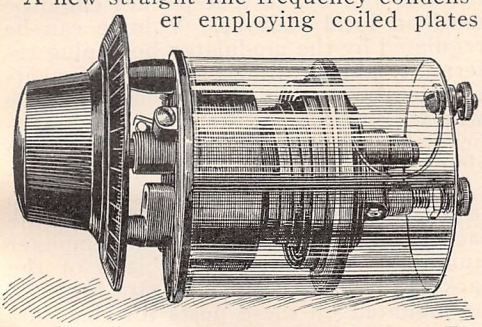
If a tube has its plate shorted to the grid or the filament, a relatively heavy current will flow in the plate milliammeter, and the pointer will swing over to maximum very quickly. Should this occur, remove the tube at once to prevent damage to the instrument; should there be a short circuit between the grid and filament, no change whatever will be noticed on switching the lever from negative to positive, since shorting of the grid renders it inactive as a controlling element.

If the tube plate emission has fallen off, values of plate current will be materially less than those shown in the table, and there will be a much smaller increase in the reading when the switch lever is thrown to the positive contact. Some tubes of low plate emission can be rejuvenated to almost their former value with any of the simple tube boosters now on the market, and when placed back in the tester will show much greater efficiency.

A large blueprint, including circuit diagram, battery connections and chart, may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago. Include 15 cents to cover postage and packing. Specify blueprint No. 111.

Straight-Line Frequency Condenser Employs Coiled Plates

A new straight-line frequency condenser employing coiled plates

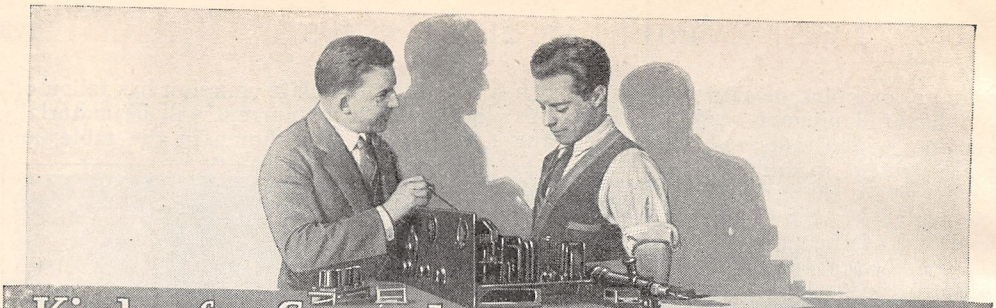


Dust-Proof Straight-Line Frequency Condenser Employs Two Shielded Plates in the Form of Coils

is interesting as a variation from the plate type in common use. It consists of two plates in the form of a clock spring; and is inclosed in a transparent, dust and moisture-proof case. The terminals are taken out through the back of the case, making a very compact and neat unit; a 4-in. dial is supplied with each condenser.

Honeycomb Coils Ideal for High Waves

For high wavelengths, honeycomb coils make an ideal form of inductance. Bank-wound and honeycomb coils, on these waves, have comparatively low resistance, and are compact and easier to handle than the old type of solenoid coils formerly used for this purpose. The large amount of wire necessary in a coil that will tune to the high waves presents a definite mechanical problem, if space is to be conserved. A compact honeycomb coil, 1 in. thick and 5 in. in diameter, can only be duplicated in inductance value by a solenoid coil 3 ft. long by 6 in. in diameter—out of all reason in the modern set.



Kinks for Superheterodyne Builders

By F. L. BRITTIN

IN fulfillment of a promise made to our readers a short time ago, Popular Mechanics radio laboratory offers the following suggestions to 1926-model superheterodyne builders. A careful check has been kept on the inquiries received and the kinks or suggestions given in this article have been prepared in answer to them.

One of the most frequent requests is for a diagram showing how to use a.f. transformers in the 1926-model instead of the resistance-coupled unit, as many have these transformers on hand and do not wish to go to the expense of buying an additional unit.

The few changes necessary are shown in Fig. 1 on the blueprint page. A phone jack and filament switch are mounted on the front panel in the positions indicated. The switch is connected in the negative line; the a.f.transformers and extra sockets are mounted on the subpanel so as to permit as short leads as possible, the arrangement being shown in the rear-view photos. The exact position of these transformers will vary according to the types used. A ratio of 2 to 1 is suggested for the second stage; the first stage may be either 6 to 1 or 3½ to 1, as desired, but the transformers must be of the heavy type now on the market if good results are to be obtained.

The maximum B-voltage required in this case is ninety; this terminal post is placed at the extreme left of the subpanel, and is connected to the frame or bottom blade of both the phone and horn jacks. A lead is also taken from this line to the B-positive terminal of the A and B voltmeters, and from the underside of the terminal post to the B-post of the second a.f. transformer.

It is also necessary to mount a 4½-volt C-battery on the subpanel, which is held in place by means of two small brass brackets; a binding post for the positive and negative leads holds these brackets in position as shown. A lead is taken from the negative-C binding post on the underside of the subpanel and run to both F-posts on the a.f. transformers; the positive lead from the C-battery is then connected to the negative-A line. All leads are shown exactly as they appear in the laboratory model, and are very simple to follow; the light leads indicate those that are run below the subpanel.

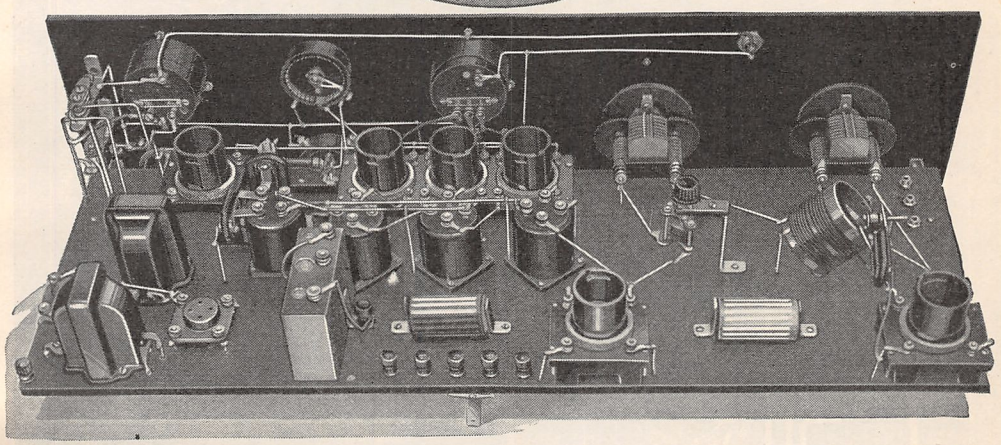
To operate the set place two 201A tubes in the amplifier tube sockets, and turn on the switch. If the phones or horn are used in the phone jack, seven tubes are in use; the eighth tube is not lighted. Plugging the horn in the filament-control horn jack lights this tube. To control the volume on the horn jack, it may be necessary to turn back the detector rheostat on the first detector tube, or a volume-control horn plug can be used; this is a new device and is known as a "modulator horn plug." A small dial mounted on one side of the plug is adjustable so that the volume can be regulated from a whisper to maximum without touching any other control on the set.

The second largest number of inquiries received from builders of this 1926-model superheterodyne asked for some means of cutting out the resistance-coupled amplifier temporarily, so that phones could be used on local stations. Volume can be regulated by the modulator horn plug referred to above without any change whatever in the present circuit, but for those who wish to cut out the resistance-amplifier unit entirely, for using the phones, the simplest method is to mount an open-circuit jack below the horn jack, and run a lead from the frame or lower blade of the jack to the input B-post on the amplifier unit, and from the upper blade of the jack to the input P-post. Extra lugs can be mounted on these posts for this purpose and no connections in the set disturbed. A blank horn plug is then plugged into the horn jack to turn on the filaments of the tubes, and the audio rheostat is turned completely off; this cuts the amplifier unit with its three tubes out of the

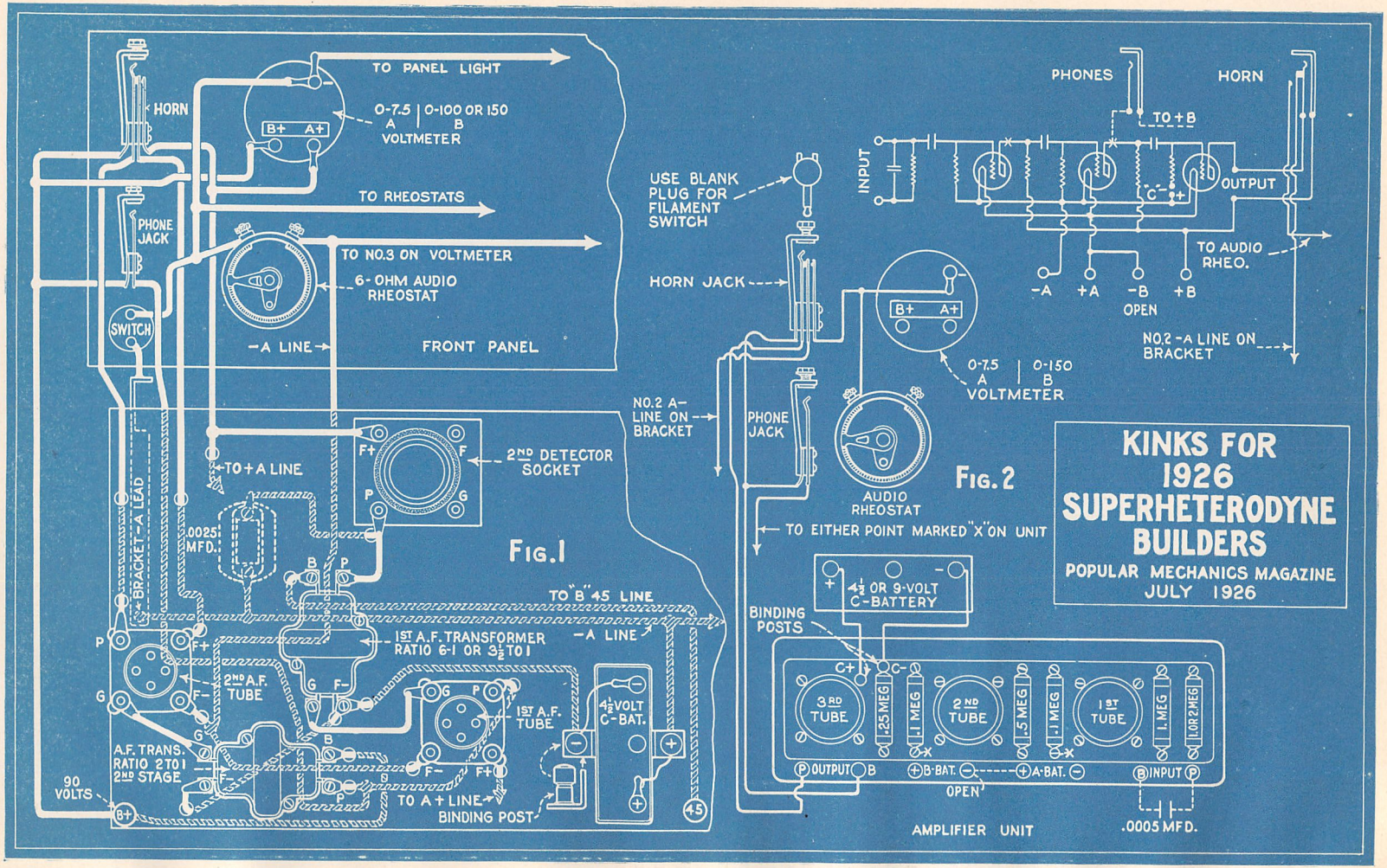
circuit, and the phones can then be plugged into the phone jack.

Cutting one or two stages out of the amplifier unit is a little more complicated, but Fig. 2, in the blueprint diagram, shows a simple method especially designed for as few changes as possible. An open-circuit jack is mounted on the front panel just below the horn jack. The output B-lead is run to the frame or bottom blade of each jack, the upper blade of the phone jack being connected to a flexible lead which is taken to either of the points marked X on the amplifier unit. The schematic diagram of the unit shows these points to be plate leads of the first and second amplifier tubes. A soldering lug can be placed under the resistor-clip screw at either point and the flexible lead soldered in place. The tubes not in use can then be removed from the amplifier unit if desired. To use the phones or loud speaker in the phone jack, place a blank phone plug in the horn jack to turn on the tubes, and plug the phones or horn in the phone jack below. Do not use Hi-Mu tubes in the amplifier unit when using the phone jack. Those who merely wish a volume control and do not care to go to the trouble of putting in the extra jack will find the modulator horn plug will reduce the volume so that phones can be used on the 9-tube load if desired.

A C-battery is a necessary addition to all sets using any type of a.f. amplification, to conserve the B-battery. The newer resistance-coupled amplifiers are provided with C-battery binding posts, as shown on the amplifier unit in Fig. 2. The C-battery is shown above the unit properly connected. If 201A or similar tubes are used, a 4½-volt C-battery is required; if the Hi-Mu tubes are used, the No. 20 types are placed in the first and second sockets of the unit and a Hi-Mu No. 6 tube is placed in the last socket, but do not use these tubes in combination with 201A tubes. With these tubes and the specified 135-volt B-battery, a 9-volt C-battery should be used. For this purpose connect two of the 4½-volt C-batteries in series. If the 201A tubes are used in the first two stages, and a 112-type power tube in the last stage, the same C-battery of 9 volts is used. For those that have the older type of resistance-coupled amplifier units, the C-battery posts are easily added. Referring to the schematic diagram, note the position of the negative C-battery connection, at the



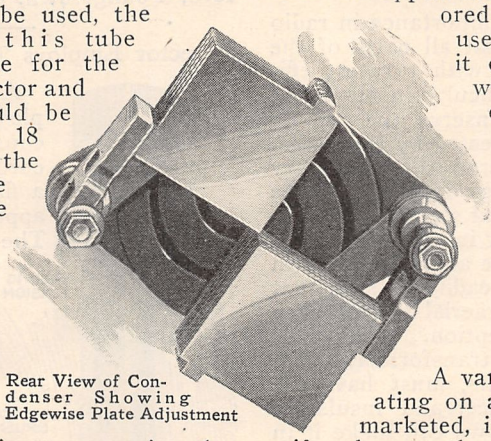
Rear View of 1926-Model Superheterodyne Employing A.F. Transformers Instead of Resistance-Coupled Amplifier; Above, Enlarged View of Amplifier Section, Showing Distribution of the Units


TO PANEL LIGHT
HORN
0-7.5 A | 0-100 OR 150 B
VOLTMETER
B+ A+
TO RHEOSTATS
PHONE JACK
TO NO.3 ON VOLTMETER
6-OHM AUDIO RHEOSTAT
SWITCH
-A LINE
FRONT PANEL
TO +A LINE
2ND DETECTOR SOCKET
F+ F P G
.0025 MFD.
B P
+ BRACKET - A LEAD
TO "B" 45 LINE
1ST A.F. TRANSFORMER RATIO 6-1 OR 3½ TO 1
-A LINE
P F+ F-
2ND A.F. TUBE
G F-
G P
1ST A.F. TUBE
G B
4½ VOLT C-BAT.
A.F. TRANS. RATIO 2 TO 1 2ND STAGE
90 VOLTS
B+
TO A+ LINE
BINDING POST
45
FIG. 1
PHONES
HORN
TO +B
INPUT
OUTPUT
C-
C+
TO AUDIO RHEO.
-A +A -B +B
OPEN
NO.2 -A LINE ON BRACKET
USE BLANK PLUG FOR FILAMENT SWITCH
HORN JACK
B+ A+
0-7.5 A | 0-150 B
VOLTMETER
NO.2 A- LINE ON BRACKET
PHONE JACK
AUDIO RHEOSTAT
TO EITHER POINT MARKED "X" ON UNIT
FIG. 2
KINKS FOR 1926 SUPERHETERODYNE BUILDERS
POPULAR MECHANICS MAGAZINE
JULY 1926
4½ OR 9-VOLT C-BATTERY
BINDING POSTS
C+ C-
3RD TUBE
2ND TUBE
1ST TUBE
1.25 MEG
.1 MEG
.5 MEG
.1 MEG
1 MEG
1 OR 2 MEG
P OUTPUT B
+B-BAT. -
+A-BAT. -
B INPUT P
OPEN
AMPLIFIER UNIT
.0005 MFD.

end of the last grid resistor; an inspection of the underside of the unit will show the resistor terminal connected with the A-negative post on the last tube socket, by means of a short metal strip. This metal strip is removed and two small binding posts are mounted in the place of the machine screws. The negative side of the C-battery is then taken to the post on the resistor clip and the positive side goes to the negative-A post on the last tube socket. The location of the C-battery posts on the upper side of the unit is clearly defined in the picture diagram of the unit.

A .0005-mfd. fixed condenser will be noted across the B and P input posts on the unit; also a 2-meg. resistor is substituted for the .1 resistor in the first input clip of the unit. With the by-pass condenser in position the r.f. current is kept out of the audio-amplifier unit and the resistor of higher value enables the operator to balance the set with ease.

Leaving the audio-amplifier section of the set, we will now consider the second detector. This tube can be either a 201A-type or a No. 20 Hi-Mu tube; a ¼-amp. "amperite," or "ballast," is used for this tube instead of a rheostat. If this resistor unit is defective, the set will have poor volume and give unsatisfactory results. The intermediate-frequency tubes should be uniformly matched, and the grid and plate leads from the transformers to the tubes as short as possible. The first detector tube can be either a 200 or 201A-type, but preferably the latter. If this type of tube is used, a 25-ohm first detector rheostat should be used, the rheostat controlling this tube only. The B-voltage for the plates of the first detector and oscillator tubes should be kept at the original 18 volts specified; use the poorest tube you have for the oscillator. The low oscillator plate voltage prevents blocking of the first detector tube and is one of the reasons for the highly satisfactory results obtained with this receiver.

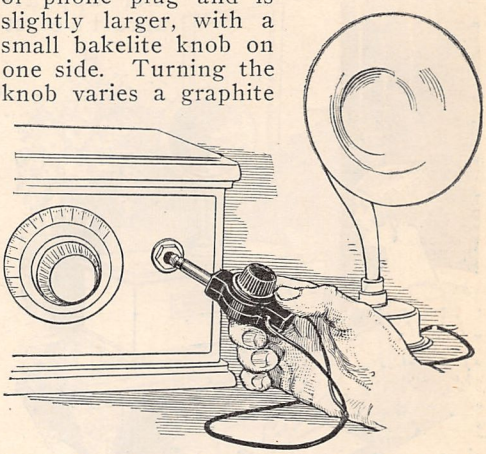


Rear View of Condenser Showing Edgewise Plate Adjustment

A large blueprint diagram covering the alterations suggested in this article may be obtained from the Radio department, Popular Mechanics Magazine, 200 E. Ontario st., Chicago. Send 15 cents to cover postage and packing. Specify blueprint No. 112.

New Plug Controls Tone and Volume

Volume and tone control without changing your set in any way can be obtained with a new modulator plug. The device takes the place of the usual horn or phone plug and is slightly larger, with a small bakelite knob on one side. Turning the knob varies a graphite resistance in the plug base. With this adjustment, the operator can regulate the volume from a whisper upward, without touching any other control.



Volume-Control Plug Connected to Horn Cord Ready for Plugging into Set

Paint on Radio Sets

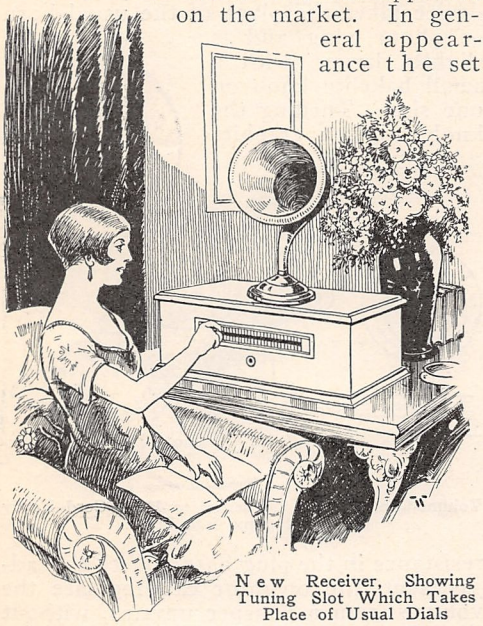
On many homemade radio sets the baseboard is given an application of paint to better its appearance. But ordinary colored paint should never be used for this purpose, as it contains ingredients which allow a slight electrical leakage across the instruments, which are mounted on the baseboard. Only a good grade of oil stain should be used.

Condenser Operates on Spiral Cam

A variable condenser operating on a spiral cam, recently marketed, is claimed to separate uniformly over the entire 360 degrees on the dial, all broadcast wavelengths from 150 to 600 meters. The cam governs the relation of the movement of the plates to that of the dial. The insulated parts are out of the condenser field and resistance losses are claimed to be extremely small.

Receiver Has Tuning Lever Instead of Dials

A new receiver employing a tuning lever instead of the usual dials has appeared on the market. In general appearance the set



New Receiver, Showing Tuning Slot Which Takes Place of Usual Dials

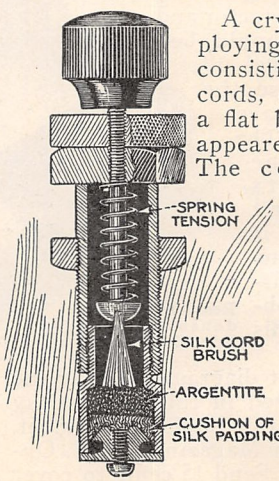
is no different from the ordinary receiver except for the calibrated slot which takes the place of the dials. A tuning knob is moved along the slot to locate stations.

Preventing Surface Losses

It is of the utmost importance in radio broadcast reception that all parts of the receiver should work with greatest efficiency. The great difficulty in most sets is the inability to conserve the minute amount of energy collected by the aerial. When it is remembered that the very small amount of energy received by the antenna from the distant station, after going through the proper instruments, must emerge in such volume as to be heard in a large room, it will readily be seen that any losses between the aerial and the horn will affect good reception. Hence all parts, such as coils, transformers, condensers and wire joints, must have the least possible resistance, and insulation must be as perfect as we can make it in order to eliminate losses. It is characteristic of electricity that it will take shortcuts from wire to wire and to the ground. If any part of the receiver allows these high-frequency currents to wander from one part to another, sensitivity will be lessened, which in turn shortens reception range, and adds other difficulties that cause the beginner much unnecessary worry. The panel, therefore, plays an important part in securing good results, and it should invariably be of the best insulating material possible, never of wood, as this will absorb moisture and is never entirely free from it. Many radio builders prefer a dull-finished panel to one having a glossy surface, as they think it looks better, but actual practice tends to show that the former is not as efficient as the glossy one. The practice of some radio builders to remove the glossy finish by roughening the surface with fine sandpaper, finishing with pumice stone and oil, is not to be recommended. The surface of a panel so treated resembles a series of minute hills and valleys. When the oil and pumice stone are applied, dust from the air is firmly fastened to the panel, and the oil collects more dust which quickly forms a high-resistance leakage path from terminal to terminal and from one instrument to another. Moisture, too, is more easily absorbed by the roughened surface and further aids the current to wander about. It is essential that both sides of the panel and subpanel be smooth. As an instance of wrong practice it may be worth while to mention the experience of a radio beginner who painted his radio panel to match the cabinet with the result that the range of his five-tube set was cut down to 65 miles with very poor reception at that, because the lead in the paint short-circuited the instruments.—W. S. Standiford, Youngstown, Ohio.

Detector Employs Tinsel Contact Brush

A crystal detector employing a contact brush consisting of forty silk cords, each wound with a flat bronze tinsel, has appeared on the market. The construction is clearly shown in the sectional view herewith. The adjustable spring insures the proper tension, the forty points of contact on the crystal improve reception, and the cushion of silk padding at the base is said to pick up all "frequency energies" and prevent corrosion.

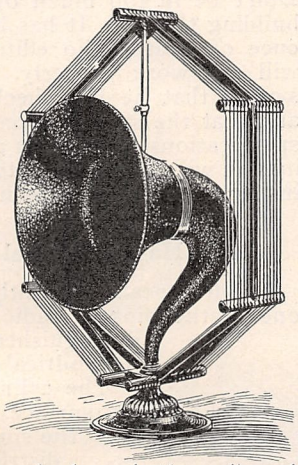


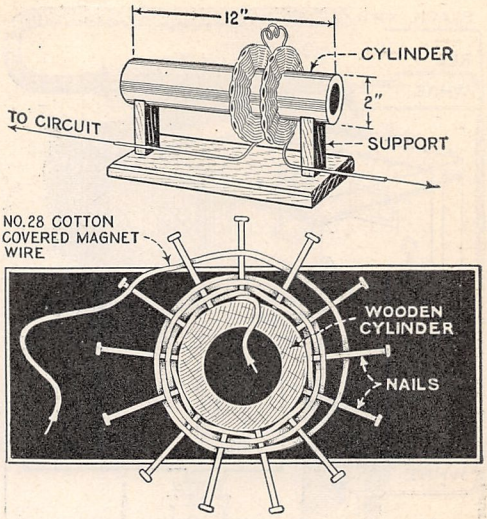
Keep the Leads Short

All leads between instruments in a radio set must be kept as short as possible. When fastening the soldering lugs on the various instruments before wiring the receiver, set the lugs so that they point as nearly as possible in the direction in which the connecting wires are to run. This will not only make for neatness and convenience in wiring, but will also improve the reception, sometimes to an unbelievable degree. Not seldom, sets are seen in which the builder seems to have gone to a great deal of trouble to make the leads as long as possible. In some, the soldering lugs were both pointed in the opposite direction to that in which the wire should have run to get the shortest possible lead, and the wire, instead of running in a straight line from lug to lug, had been so bent that it was actually four times as long as it should have been. In an extreme case, the grid leads, which, by slightly rearranging the transformers and sockets, could have been kept down to ¾ in., were, when measured, 4¼ in. long, a considerable difference, and one that was apparent in the operation of the set.

Loop Aerial Combined with Loud Speaker

A loop aerial that can be combined with any loud speaker of the type shown in the illustration, is now available. This combination makes a practical, attractive and efficient unit in a very limited space. The wires are held in their proper relation by insulated spacers. To install the loop, the base of the horn is removed, and the loop clamped to base with two springs; the horn is then slipped between the latter. A sliding pivot at the top of the loop is adjusted to carry its weight at the proper height and directly over the base of the horn; the point of the pivoting rod is then pressed into the horn and the unit is ready for use. Compensating springs at the bottom make the loop fit the horn and permit it to revolve.



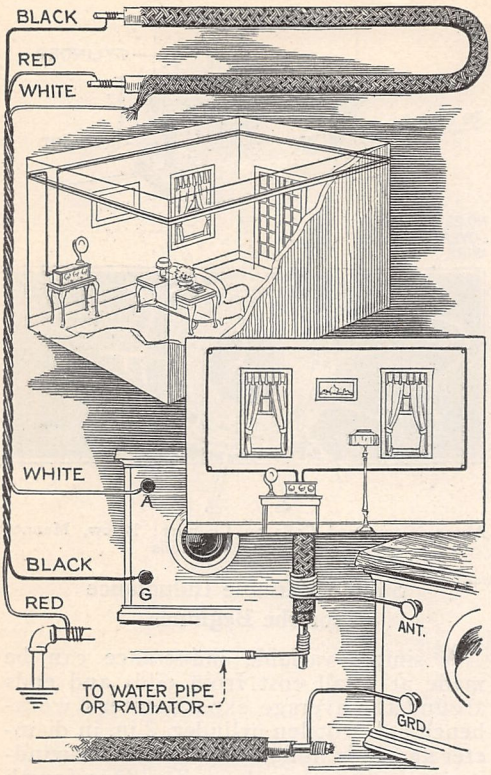


Above, Completed Coils on Cylinder; Below, Manner of Winding the Coils

Simple Variable Inductance for the Beginner

A simple variable inductance can be made at small cost from odds and ends around the average experimenter's workbench. A wooden cylinder, 2 in. in diameter and 12 in. long, is used both for winding and mounting the coils. One-fourth pound of No. 26 c.c. magnet wire will be sufficient for the coils. Close to one end of the cylinder, drive 13 nails into the cylinder at equidistant points around its circumference as shown in the lower illustration. This makes the form for winding the coils; wind the wire in and out around the nails so as to have a coil about 4 in. in diameter when completed. Dip the coil in melted paraffin, and when cool, remove the nails and slip off the coil. Make another coil in the same manner, and mount the two coils on the cylinder so that they can be moved toward or away from each other. Then connect them as shown; if good results are not obtained at first, reverse the connections between the coils. Support the cylinder on two small wood blocks, using brass wood screws to hold them in position. The proper inductance is gauged by the distance separating the two coils.—Stanley Radcliffe, Laurel, Md.

¶Dry cells can be revived temporarily by punching holes in the base and soaking the battery in vinegar for 24 hours. This charge will not last long, but will answer in an emergency when new cells are not immediately available.



Indoor Aerial, Which Combines Wave Collector with Condenser and Filter Effects

Indoor Aerial of Unusual Design

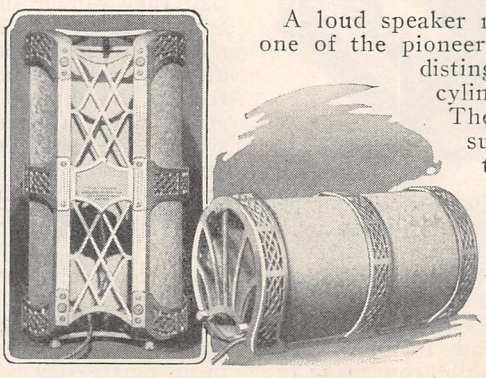
A new and unusual type of aerial for indoor use has a center core of solid copper, over which a rubber insulation of high quality is placed, while the covering consists of braided tinned-copper wire. When this antenna is used in the form of a loop, the inner core acts as a magnetic return ground, designed to increase selectivity and tone quality; when used as a straight aerial the outside tinned-copper braid, because of its large surface area, is an ideal wave collector, the inner core acting as a magnetic-field ground. This dual-conductor construction has the effect of a condenser the full length of the aerial, and is claimed to be an ideal filter for grounding out or neutralizing noises, leaving the aerial to bring in the radio waves without distortion. If used in the attic or around the room, it is unnecessary to use insulators.

Read the Article Too

One of the commonest faults of the home radio builder, making a set from a description published in a magazine, is that he "reads" only the pictures, drawings and list of materials. More often than not, the article itself contains information that is vital to the successful building or operation of the set, information that cannot be incorporated in the drawings, and, if the prospective builder skips the reading matter, he will wonder why his set does not work as expected. Another very common fault is substitution, either of materials or in methods of placing instruments and of wiring the set. Radio writers do not specify certain instruments because they prefer one or two particular makes, but because they have found that these work best in the set described. In another type of set, entirely different instruments may work best. In many sets, any condenser, transformer, coupler, etc., will work well, but, where the writer specifies a certain instrument, the builder should use it and no other. If he does not, he may not have any trouble, but the chances are that he will, and then he will blame the writer instead of himself. Don't be in too much of a hurry when building the set. It has been the experience of many radio editors, when a set will not work properly, and the reader swears that he has checked every wire, and that the set is "exactly according to specifications," that even a cursory examination will show one or two points where instructions have not been followed.

Horn Has Cylindrical Diaphragm

A loud speaker recently developed by one of the pioneer radio laboratories is distinguished by an almost cylindrical diaphragm. The cylindrical vibrating surface is said to cause the sound waves to be distributed in a more natural manner than when projected in one direction, and give equal reproduction of all frequencies. The instrument can be used in either a horizontal or upright position.



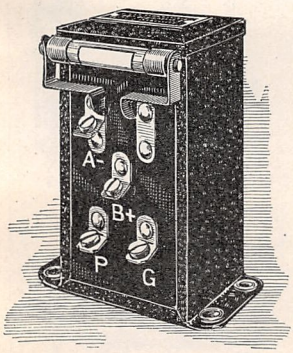
Cylindrical Loud Speaker Can Be Used Either in an Upright or Horizontal Position

Iron in the Set

Don't use iron of any kind in the radio set. It may be in a place where it will do little or no harm, but ten to one, it will be the cause of several mysterious noises. One builder ran out of brass strip when building a superheterodyne, and decided that several small iron angles that he had on hand "would do well enough" for the contacts of the small 1½-volt flashlight cells used in the set. After the set was finished, he was troubled with a persistent hum, and, after checking and rechecking the circuit many times without discovering wherein he had made any error, he called in an expert. The latter was also puzzled for some time, but finally noticed, almost accidentally, that whenever a wire that ran directly beneath the iron angles was moved to one side and held there, the hum disappeared. Substituting brass for the iron cured the trouble immediately.

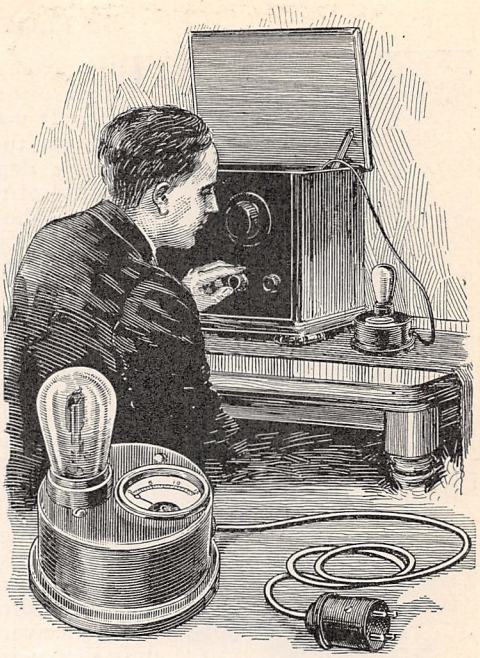
Compact Impedance Amplifier Unit

Compact audio-frequency amplifying units of the impedance-coupled type, recently put on the market, combine the choke coil with the gridleak and grid condenser, greatly simplifying the wiring. It is installed in the set in the same manner as ordinary a. f. transformers and takes up very little space on the subpanel. Three stages are used instead of the usual two a. f. transformers for practically the same volume. The tone, however, is claimed to be superior



New Detector Tube Uses Small Plate Current

A detector tube, recently developed by Mr. Harold P. Donle, is said to be sensitive to a degree hitherto unapproached by any other tube. The electrical characteristics are somewhat similar to those of the Sodion tube, and it can be operated without either potentiometer, gridleak or grid condenser. The plate impedance is very high. With 22 volts, the plate current is only .1 milliamp., the filament current being .25 amp. at 5 volts.



Tube Being Tested under Operating Conditions, Rheostat on Set Controlling Filament Supply

Instrument for Checking Radio Tubes under Operating Conditions

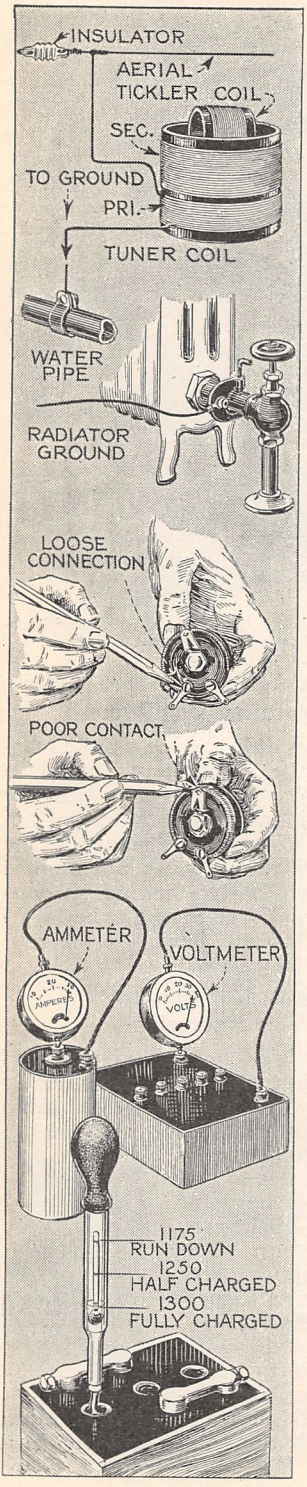
Checking tubes at home is a simple matter with the little instrument shown in the illustration. Each tube can be checked under identical conditions of actual operation. The tube is placed in the instrument, and the plug is put in the socket of the set. After making all connections, the condition of the tube is indicated by the milliammeter.

Soldering in Corners Aided by Wire Extension

A short length of busbar wire wound around the copper bit aids in soldering joints in awkward places. The radio builder, working with a man-size soldering iron, is frequently hard put to find a way of getting the point into some out-of-the-way corner of the set. The method of fastening the wire to the bit is clearly shown in the illustration; the projecting end should be long enough to reach the desired point, and sufficient heat will be transmitted through the wire to melt the solder and obtain a good joint.—A. C. Cole, Chicago.

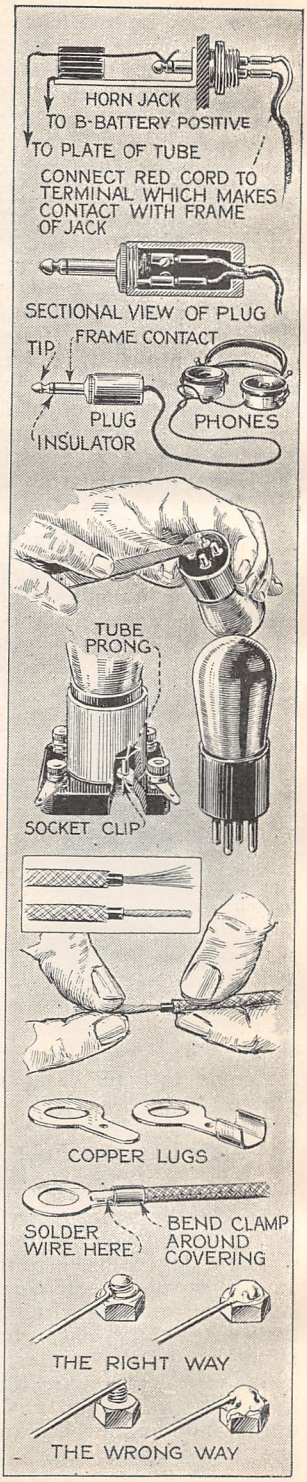
What's Wrong with Your Set?

By FLOYD GRAHAM



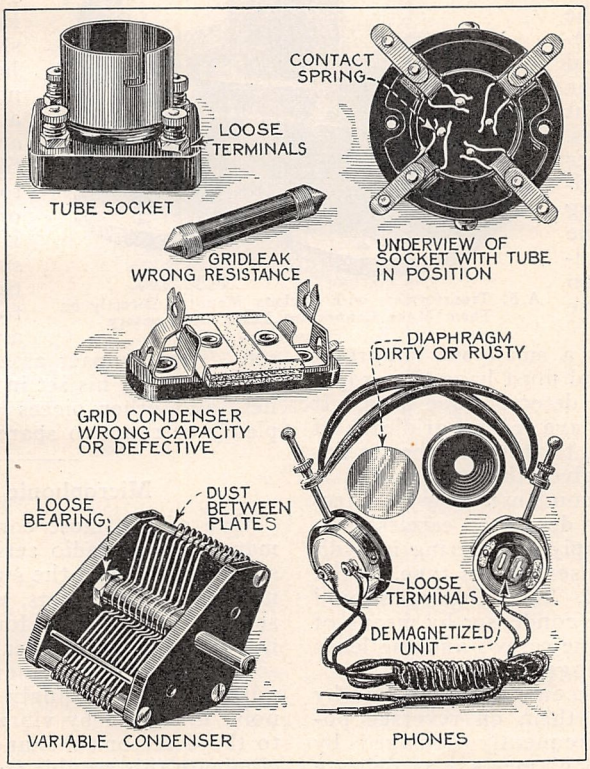
THE detector is the heart or mainspring of the radio receiver. It may be a crystal or a vacuum tube, but upon its efficiency depends the performance of the set. The purpose of the detector is to change the radio waves at the receiving set from high-frequency (above audibility) to audio-frequency so they can be heard. The necessary circuit for bringing about this change and delivering the audio frequencies to the headphones or loud speaker, where the electrical impulses are converted into mechanical sound waves. is called the detector circuit.

Many things can go wrong or be wrong from the first with the various units that make up this important part of any radio receiver. The tuning unit shown is a common one, used in receivers of the three-circuit type, and will do for illustrating the faults that may exist. We will first consider the winding; the turns may be shorted, due to solder droppings, or frayed insulation, and in this case the coil must be rewound. Enameled or d.s.c. wire is the best for this purpose. Weak signals are often caused by the connections to the tickler coil being reversed, for which the remedy is obvious. The aerial must be well insulated, to conserve the minute energy picked up from the transmitting station, so that losses will not occur between the aerial and the set. Cracked, or otherwise defective, insulators permit this feeble energy to leak to the ground through the accumulated dirt and moisture in these cracks. All aerial connections should be well soldered to insure a good electrical path; this also applies to the ground connections. If a water pipe is used, all paint and rust must be filed away before connecting the ground clamp. The ground clamps shown are of the approved type and insure



a good tight connection that does not require soldering.

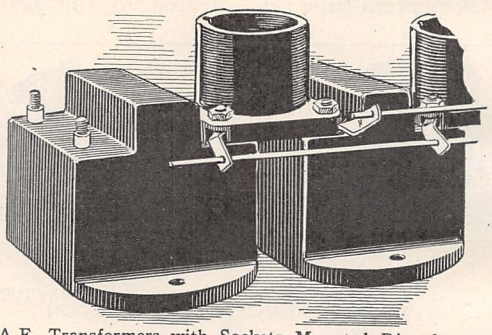
Rheostats are units that are apt to go wrong; the terminal screws may work loose, or the sliding arm may make poor contact on the resistance wire. Tighten the screws and, if the sliding arm is loose, remove the rheostat and bend the arm so that it will make good contact when reassembled. Loose rheostat connections often cause the tube to flicker, resulting in weak and irregular signals. A vacuum-tube set requires an A and B-battery, which must be effective, or good reception cannot be expected. If the filament battery is of the dry-cell type, the cells can be checked with an inexpensive ammeter; when the cells fall below 10 amp., they should be discarded. If a storage battery is used, it should be tested with a hydrometer, care being taken not to spill the electrolyte, as it is corrosive. The method of reading the hydrometer is clearly shown in the illustration. The dry-cell or storage battery referred to is known as the A-battery and is used to light the filament of the tube. The B-battery usually consists of a number of dry cells connected in series, in one or more units, and the voltage is relatively high. Good volume and clear signals depend on the efficiency of this battery. The standard B-battery voltage for the detector tube ranges from 18 to 45 volts, depending on the tube used. These batteries are tested with a voltmeter in the manner shown, and, if found to have only two-thirds of the rated voltage, should be discarded.



Proper polarity of the phones and horn makes a great difference in the volume and quality of the signal. The phone cords are usually marked for polarity; the positive cord tip being indicated with a red tracer cord and standard phone plugs are now marked for this positive connection. If not, trace the connections to the jack as shown. The positive B-battery connection should be on the frame of the jack. The frame makes the connection to the shaft of the plug, and the tip of the plug, separated by an insulator, as shown, makes the contact to the blade of the jack connected to the plate of the tube. The vacuum tube must make a good contact in its socket; the prongs also must press firmly against the spring clips, and these points of contact must be kept clean. The tube prongs are tipped with solder, and a slight corrosion at these points will often give poor contact; a nail file can be used to brighten these contacts, but take care not to file any more than sufficient to brighten the points.

Careless wiring will produce poor results sooner or later. If stranded insulated wire is used for the circuit, carefully remove the insulation at the point of contact, and twist the strands firmly together before soldering. Soldering lugs should be used under all terminals and the wire soldered to the lug. These lugs are made of tinned copper and come in a variety of shapes. If round tinned-copper busbar wire is used, and this is advised, a loop can be formed at the end of the wire, making a good mechanical contact before the solder is applied. Both the right and wrong way of making these connections are shown. Merely laying the wire on the terminal to be connected and applying the solder makes a very poor contact both mechanically and electrically. Poor in-

sulating material in the socket will cause a surprising loss of efficiency. Examine the socket and, if it is of the cheap "mud" construction, discard it. The spring clips in many of the new sockets are of the type shown in the underview illustration. It will be noted that the clips make a firm contact with the sides of the tube prongs, offering a much greater contact surface. Some sockets are constructed so as to make both end and side contacts. See that the terminals on the socket are tight; it may be necessary to remove the knurled nut, and tighten the lower hexagon nut with a pair of pliers. Some of the newer sockets are provided with soldering clips instead of the knurled-nut terminals, in order to minimize loose connections.



A.F. Transformers with Sockets Mounted Directly on Them Make Connecting Leads Unnecessary

The gridleak is a small but important part of the set, and must have the proper resistance for the detector tube used. It is a good idea to have several gridleaks of various values and try them in the set until the one that gives the best results is found. The grid condenser may be defective due to faulty design or careless soldering. Never apply a soldering iron directly to a condenser of this type, as the heat will destroy it. Soldering lugs should be fastened to the condenser by means of short brass machine screws and the leads soldered to these lugs.

Phones often become demagnetized by continually using them on reversed polarity, and are frequently damaged by dropping, as good phones are as delicate as a watch. In cases of this kind, it is best to return them to the manufacturer for repair. Keep the diaphragms free from rust and dirt; these thin disks must be in good condition or the quality and strength of the signals will suffer. The phone-cord terminals fastened to each unit must be kept tight, and the cord itself should not be allowed to become badly twisted. The delicate tinsel conductor is easily broken, resulting in crackling and popping noises in the phones. Renew the cords when they show signs of hard use. All these remarks, of course, apply also to the loud speaker.

Variable condensers are not the source of as many troubles now as they were in the past due to better design and construction, but loose bearings and dust accumulation between the plates will result in poor operation even with the best types. Keep them clean, and keep the bearings tight for best results.

A.F. Transformers Eliminate Unnecessary Wiring

A.f. transformers and sockets, so designed that connecting leads are unnecessary, are now available. It is a well-known fact that short leads produce best results, eliminating feedback and preventing loss and distortion. Sharp tuning and tone quality depend on these factors. Units of this type simplify construction and add much to the appearance and efficiency of the set. The compact assembly permits the builder to put his set in phonograph cabinets and other pieces of furniture with plenty of room to spare.

Microphonic Noises

One of the most common troubles in manufactured radio sets having ordinary sockets riveted to the subpanel, as well as many homemade sets, without shock-absorber sockets, is a loud, clear, ringing noise in the loud speaker, which starts softly and gradually increases in intensity until it is exceedingly annoying. This noise is caused by vibrations transmitted to the detector tube, and the best way to eliminate this trouble is to install a cushion-type socket for the detector tube. You will also find that one tube may be much more microphonic than another, so change tubes until you get a good one and then mark it. Microphonic noises are seldom caused by vibrating r.f. or a.f. tubes. Another temporary method of eliminating microphonic noise is to mount both the radio set and the loud speaker on sheets of sponge rubber.

See to it that the flare of the horn does not face the radio set directly as even the air vibrations caused by the loud speaker will affect the delicate detector tube. The loud speaker should not be set directly on the cabinet for the vibrations are easily transmitted in this way.—E. R. Haan, Chicago, Ill.

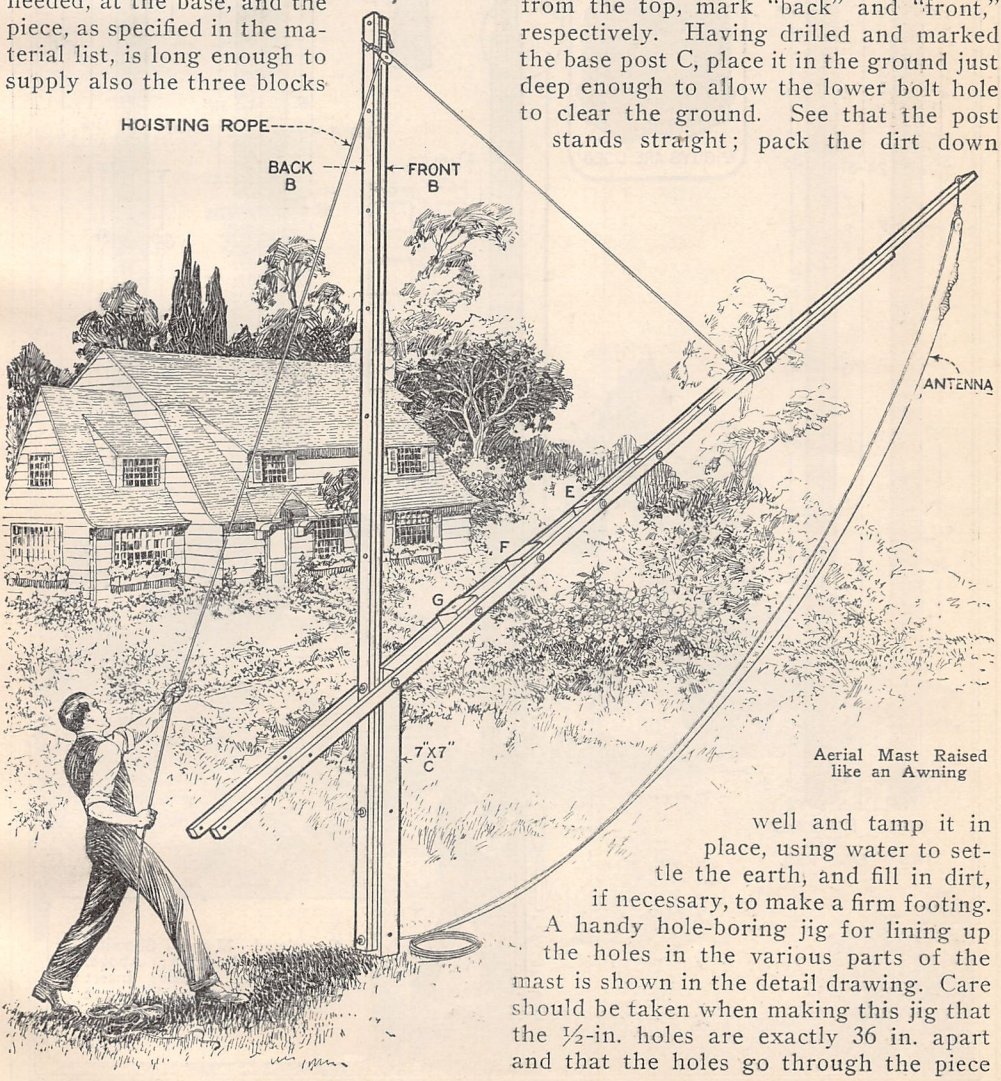
You Can Raise This Aerial Mast Alone

By HENRY S. LARABY

SIMPLE to build, strong and easily raised, this aerial mast is neat in appearance, and the materials required are not expensive.

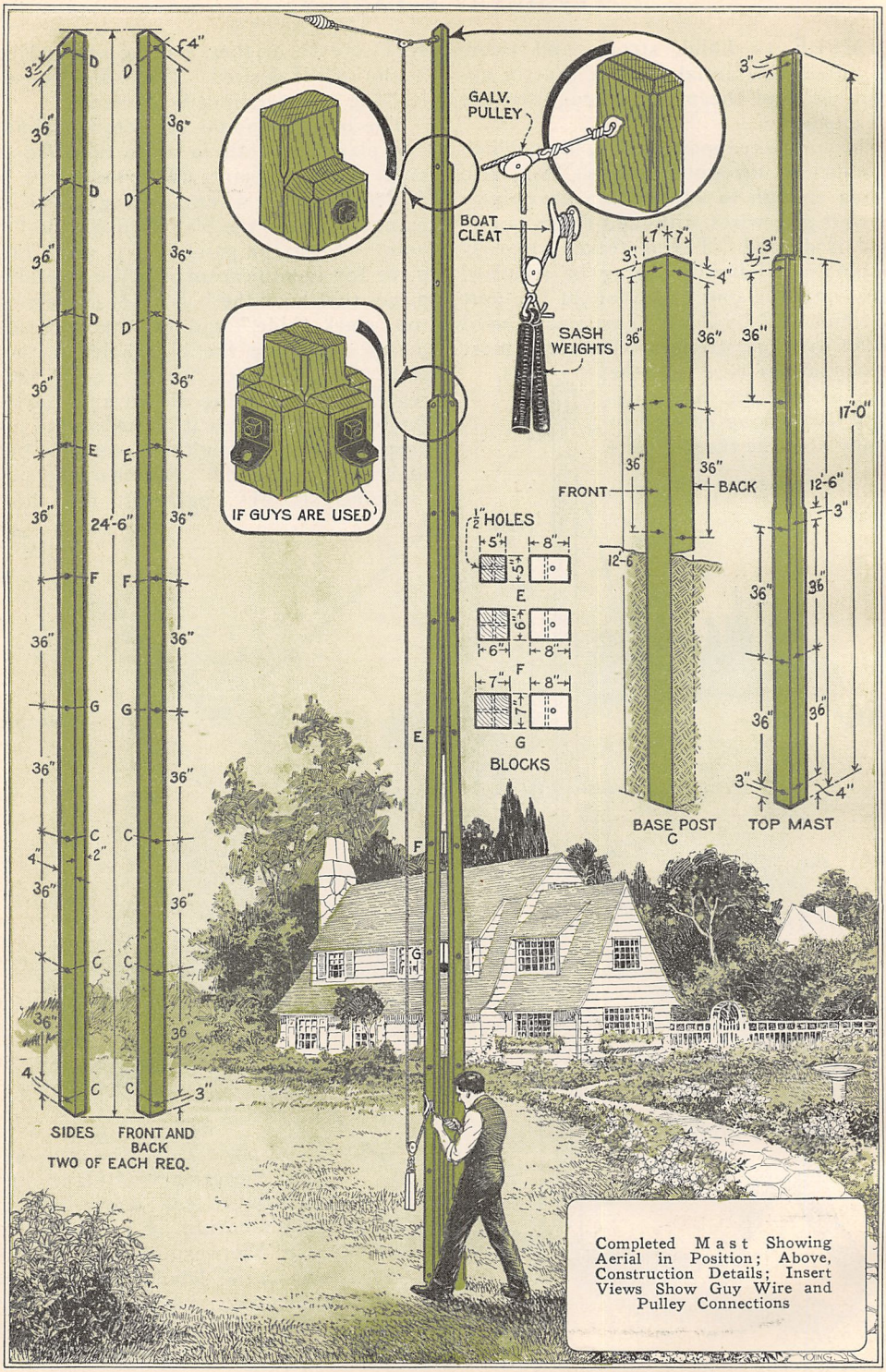
The completed mast is 35 ft. high, which is sufficient for good results; it is also strong enough to withstand a heavy gale without guy wires, although these can be used if desired. The materials are easy to obtain, all lumber being of standard sizes with the one exception of the post C, which is 7 by 7 in. This size is used to increase the strength where it is most needed, at the base, and the piece, as specified in the material list, is long enough to supply also the three blocks E, F and G, or they may be ordered cut at the mill if desired. These blocks are 8 in. long and need not be tapered.

The lumber should be free from knots and planed smooth so as to take a good coat of white paint. The holes are all drilled first and, when painting, allow the paint to run all the way through the bolt holes. After the paint is dry, mark each piece for identification; on the two side-pieces that have the bolt holes nearest the top, mark "side," and on the two side-pieces that have the bolt holes farthest from the top, mark "back" and "front," respectively. Having drilled and marked the base post C, place it in the ground just deep enough to allow the lower bolt hole to clear the ground. See that the post stands straight; pack the dirt down well and tamp it in place, using water to settle the earth, and fill in dirt, if necessary, to make a firm footing.



Aerial Mast Raised like an Awning

A handy hole-boring jig for lining up the holes in the various parts of the mast is shown in the detail drawing. Care should be taken when making this jig that the ½-in. holes are exactly 36 in. apart and that the holes go through the piece

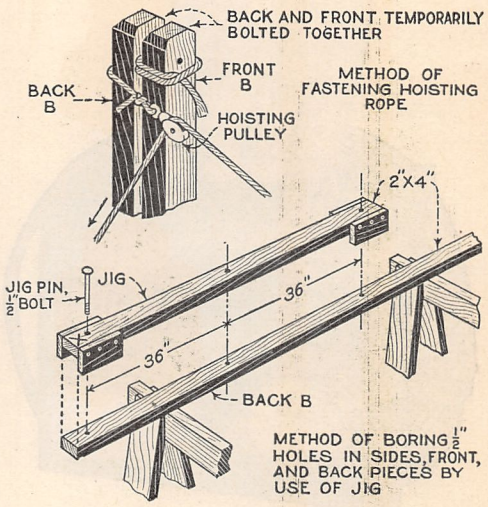


Completed Mast Showing Aerial in Position; Above, Construction Details; Insert Views Show Guy Wire and Pulley Connections

perfectly straight. The jig should be of the same width as the pieces to be bored, so it will not move while the drilling is being done. Mark one end of the jig with an "X," so that this end can be placed in the same position when all the pieces are bored. Be sure the bit cuts a clean hole, and work away from the first hole bored. The holes in the 7 by 7-in. piece can be bored halfway from each side insuring a straight-line hole through the piece.

The piece that has been marked "front" must face in the direction of the aerial wire that is to run from the top of the mast. When the mast is finished, this piece must stand straight up and down against the base when they are bolted together; so, before going farther, make sure that it is straight, using a level if necessary. The two front and back pieces B are then temporarily bolted together, and a pulley is fastened to the top of these pieces with a piece of rope, as shown in the detail drawing. The end of a 60-ft. braided clothesline is threaded through this pulley. Now set the pieces upright against the back of the post C, as shown in the drawing on page 297, and bolt them to this post temporarily. The short rope holding the raising pulley is looped around the back piece at the top, so that the strain of raising is equally distributed on both pieces.

The next step is to assemble the side-pieces and top unit; the former are bolted to the blocks, as shown at E, F and G, while on the ground. The top unit is then assembled and bolted in place; a pulley for the aerial is permanently fastened to the top of this unit and the halyards threaded through it and coiled at the base of the mast, so as to be ready when required. The upper part of the mast is now ready for raising, and is mounted on the base post with one bolt and hoisted into position. Now run the other two side bolts through the base post, and then remove the back piece B from its temporary position, freeing the raising pulley which falls to the ground. The back and front pieces B are then bolted in place in front



and back of the base post, giving added strength to the assembly. Paint the bolt heads and nuts to prevent rusting, and the mast is completed, and ready for the aerial.

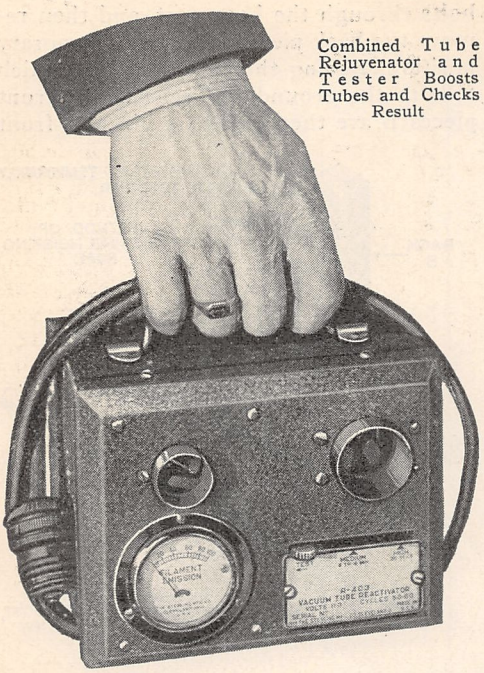
If you do not wish to use more than one mast, the other end of the aerial can be fastened to some high part of the house or other high position near the point where the lead-in wire is to be taken to the set. A boat cleat is screwed to the base post at a convenient height for fastening the halyard after the aerial wire has been drawn taut. It is suggested that two sash weights, fastened to a small pulley, be used in the manner shown in the full-page illustration. This keeps the aerial tight at all times, yet allows sufficient slack to prevent the wire from breaking in high winds. This device also prevents swaying of the aerial, a common trouble.

MATERIAL LIST

4 pieces, 2 by 4 in. by 24½ ft., yellow pine.
1 piece, 7 by 7 in. by 14½ ft., yellow pine.
1 piece, 2 by 4 in. by 17 ft., yellow pine.
1 piece, 2 by 4 in. by 12½ ft., yellow pine.
1 piece, 5 by 5 by 8 in., yellow pine.
1 piece, 6 by 6 by 8 in., yellow pine.
1 piece, 7 by 7 by 8 in., yellow pine.
8 ½ by 12-in. galvanized carriage bolts.
10 ½ by 10-in. galvanized carriage bolts.
2 ⅜ by 3-in. galvanized eyebolts.
2 galvanized pulleys.
1 piece galvanized wire, No. 12 gauge, 3 ft. long.
75 ft. ⅜-in. rope for halyards.
60 ft. cheap clothesline.

Tools Required

Crosscut saw, square, rule, monkey wrench, level, brace, ½ and ⅜-in. bits, hammer, spade and plane.



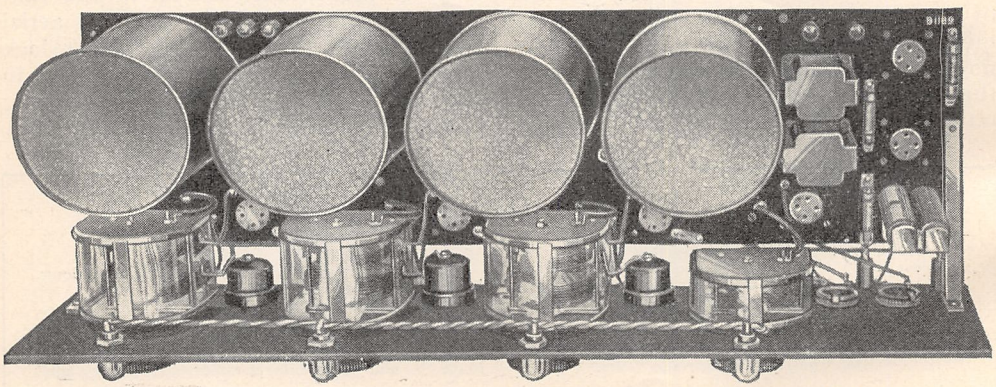
Combined Tube Rejuvenator and Tester Boosts Tubes and Checks Result

Tube Rejuvenator and Tester

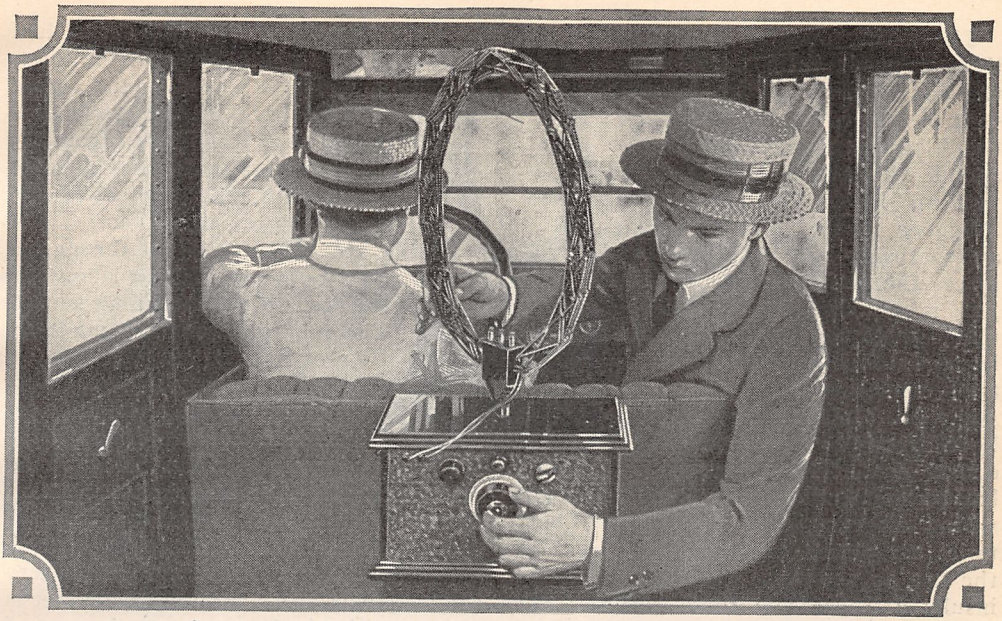
A tube rejuvenator combined with a tester, which tells the operator when tubes need boosting, checks the emission improvement during treatment and determines the filament emission afterward, takes the guesswork out of this very helpful operation. It can be used with any of the UV, UX, C or CX-tubes and is made in two types, one for 50 to 60-cycle supply and the other for 25 to 40-cycle frequency. The instrument is 6 by 7½ by 5 in. high, weighs 4¾ lb. and is provided with a handle for carrying.

"Canned" Units Feature Latest Set

"Canned" coils and balanced capacities are features of several new sets. The six-tube receiver shown in the illustration is a notable example of this method of construction and has many features of interest. The past year has shown great activity in the development of tuned radio-frequency circuits. In the early stages of this development, it was the general opinion that this type of circuit was limited by the capacity coupling between the elements of the tubes. Many methods of overcoming this trouble were tried out and one of the best solutions found was the application of the Wheatstone-bridge principle in balancing the capacities. A simple variation of the bridge is employed in the set here under consideration and the method is further improved by the use of high-efficiency coils completely inclosed in metal shields or "cans." The result is a receiver highly selective, having increased amplification without the howling and squealing that previously limited the amount of amplification obtainable; the shielded coils render the energy pick-up from powerful near-by stations almost negligible. Other interesting features are the semi-shielded condensers of special design. Each condenser is inclosed in a transparent dust-proof case, and the panel lights over each dial make tuning in dimly lighted rooms much easier. The receiver has been tested by Popular Mechanics Radio laboratory on a 30-ft. inside aerial, bringing in Texas, New York, Colorado and Louisiana stations, through locals, with clarity and good volume.



Interior View of the Set, Showing "Canned" Coils and General Layout of the Receiver; Notice the Panel Lights over Each Dial to Make Tuning Easier in Dim Light



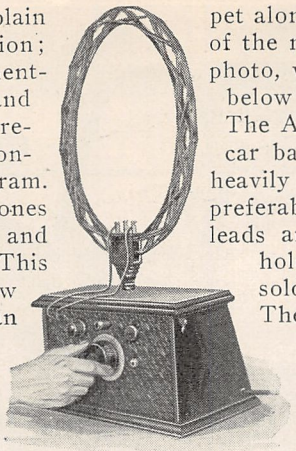
A Radio Set for Your Car

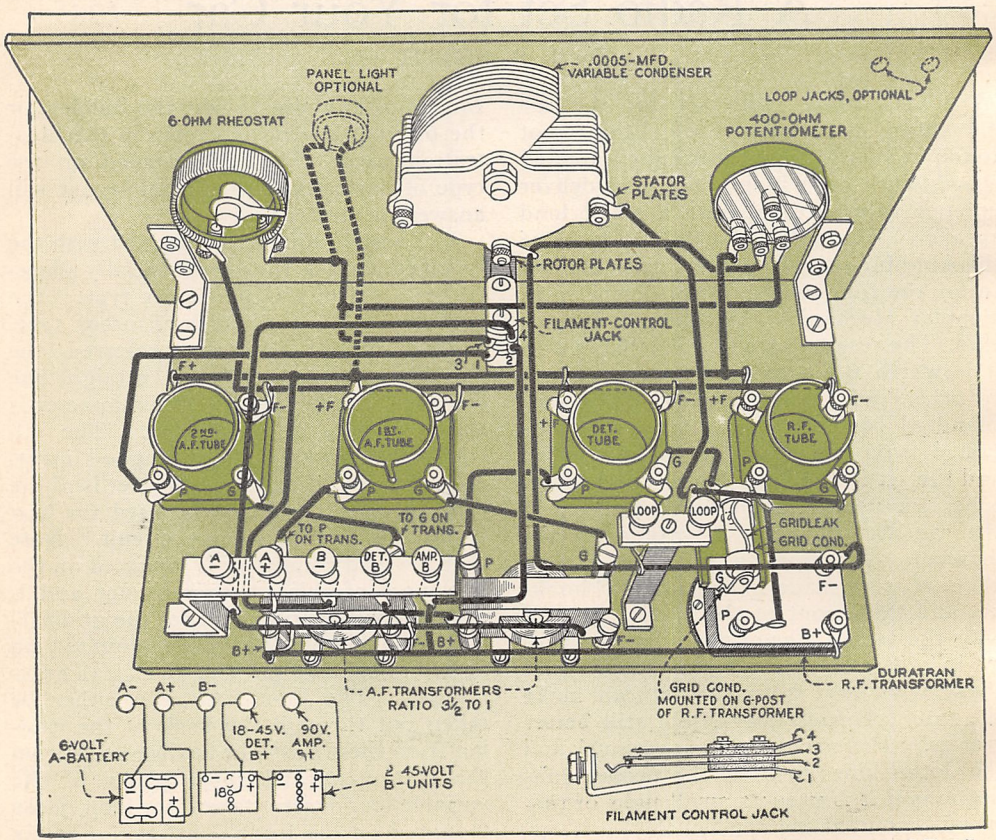
By J. B. SMITH

A REAL good radio set for the car must meet several conditions not found in all sets; it must occupy a limited space, work on a loop aerial, and deliver enough volume to operate a small loud speaker. The author looked for a set of this kind for some time and finally decided to try the four-tube loop set described in Popular Mechanics Magazine of August, 1925. The results were so good that I think it is worth while to pass the idea along to others who would like to try it out. Standard parts are used that can be obtained from any dealer in radio supplies and the set is simple to build. Four 201A tubes are used and the 6-volt battery in the car furnishes the A-battery for the filaments of these tubes. No radical changes were made in the original hook-up, and the layout of the parts is practically the same. The original diagrams are given with the few changes made, and those who have built the set can make the same changes and obtain still better results. The panel light is optional and the dotted lines indicate the proper connections if it is used; a small light of this type is useful at night when the set is operated in the car. The panel and subpanel can be of any size to suit the builder, or the original layout, as shown in the illustration used. This will depend on the type of parts, but the original layout will answer in most cases.

The best results were obtained with the specified parts as they are especially adapted for a set of this particular type. The sockets are of the shock-absorber type, "sponge-rubber" cushion preferred, the variable condenser is the old straight-line wavelength kind and the potentiometer is the noiseless, graphite type. The a.f. transformers can be of any good make, 3½ to 1 ratio; the r.f. transformer is of the type specified and must be used for best results in this particular circuit. Note that the grid condenser is mounted on the grid post of this r.f. transformer and is provided with spring clips for the gridleak. The loop binding posts are mounted on a strip of bakelite screwed to a small brass bracket. The loop leads can either be taken out through the back of the cabinet from these posts, or flexible leads from the stationary and rotor plates of the variable condenser taken to loop jacks mounted on the front panel at the points indicated, and the loop posts eliminated.

The wiring diagram is so plain that it needs little explanation; the construction of the filament-control jack is shown below and the blades numbered to correspond with the numbered connections in the wiring diagram. Plugging in the horn or phones automatically lights the tubes and places the set in operation. This jack is mounted directly below the variable condenser, but can be shifted to either side, and the condenser lowered if you wish to place the panel light directly above the condenser dial. The ordinary battery connections are shown below the wiring diagram; the two 45-volt B-batteries are placed under the back seat of the car as shown in the photo. Well-insulated leads from these batteries are twisted together and run under the carpet along the edge, to the socket half of the multiplug, shown in the lower photo, which is placed in the corner below the back of the front seat. The A-battery leads taken from the car battery terminals, should be of heavily insulated battery cable, and preferably run through loom. These leads are then taken up through a hole bored in the car floor and soldered to the multiplug socket. The multiplug cable is made up of various colored wires that are taken to the terminal posts in the set through a hole drilled in the cabinet. The plug and socket are marked so that the correct connections are made when the plug is shoved in the socket, connecting both A and B-batteries. This type of battery connection is also handy when the set is to be used in the house on another set of

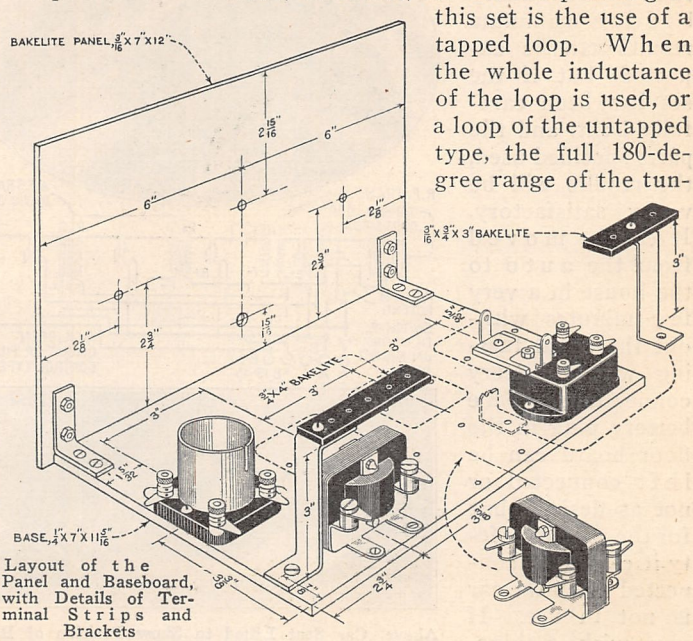




Wiring Diagram Showing Lugs under All Terminals to Be Soldered; Below, Battery Connections and Details of Filament-Control Jack

batteries. The loop can be any small tapped type, and is mounted in a convenient position on the top of the cabinet; flexible leads from the loops are connected to loop-plugs and plugged into the loop-jacks as shown in the illustration.

The cabinet for the set can be of the standard type, or homemade as was the case with the one shown in the illustration. It is mounted on the back of the front seat by means of two shelf brackets of the type ordinarily found in the five and ten-cent stores. The loud speaker can be one of any of the small types on the market and is mounted up in one corner of the car at the rear, and does not show in the photographs. The horn cord is tacked along the inside of the car so as to be out of the way and brought down to a point near the set. The horn plug is fastened to the cord and when the set is not in use this plug can be dropped into one of the side pockets of the car. The set tunes very sharp and the loop must be rotated in the direction of the sending station for best results.



Layout of the Panel and Baseboard, with Details of Terminal Strips and Brackets

To operate the set, plug in the horn and turn up the rheostat. Then slowly rotate the condenser dial until a station is picked up. Volume and clarity are obtained by adjusting the potentiometer, and with a little practice really remarkable results can be obtained. Keep the rheostat turned down as low as possible for best results, and be sure to remove the horn plug when the set is not in operation. One reason, of course, for the sharp tuning of this set is the use of a tapped loop. When the whole inductance of the loop is used, or a loop of the untapped type, the full 180-degree range of the tuning condenser varies between wavelengths of 370 to 550 meters; when the center tap is used on a tapped loop the condenser range varies between 150 and 400 meters. This method of tuning not only brings in the lower waves better, but completely cuts out the higher-wave stations; at the same time separating stations by several points more on the dials than in the usual way.

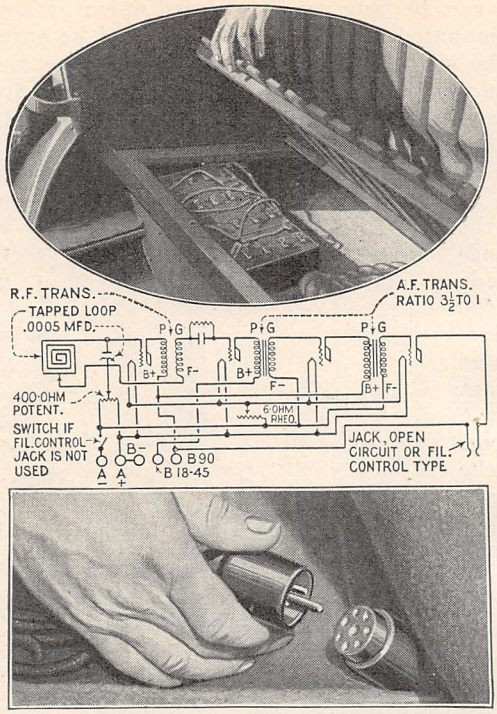
When located several miles from the broadcasting station, the dial has to be set right on the dot to bring the station in, and so, of course, a good vernier dial is essential to the successful operation of

MATERIAL LIST

1 tapped loop.
1 7 by 12-in. cabinet.
1 7 by 12-in. panel.
1 7 by 11½-in. baseboard.
1 low-loss variable condenser, .0005 mfd.
1 vernier condenser dial.
1 400-ohm potentiometer (Centralab or similar type).
1 6-ohm rheostat.
1 filament control jack.
1 .00025-mfd. grid condenser (with gridleak clips).
1 2-megohm gridleak.
4 standard sockets (shock-absorber type).
2 a.f. transformers, ratio 3½ to 1, any good make.
4 201A or 301A tubes.
7 binding posts.
2 small angle brackets for mounting front panel.
2 large shelf brackets for mounting cabinet in car.
1 Jones multiplug, type BP.
2 cord-tip jacks and plugs.
2 45-volt B-batteries, large flat type.
4 oval-head nickelplated screws.
3 two-foot lengths round tinned-copper busbar wire.
1 bakelite strip, 3-16 by ¾ by 4 in. (for battery terminals).
2 4½-in. brass strips, 1-16-in. stock, ½ in. wide.
1 Duratran r.f. transformer.

the set on distant stations.

Some practice in tuning is necessary before maximum results can be expected, but if the set has been carefully built, and the parts specified used, the results will be very satisfactory. It can be moved from the auto to the house in a very few minutes without the usual fussing with battery connections. The battery plug in the floor board can be left connected or not as desired, but for the sake of safety it can be disconnected when the car is not in use. If you wish a blueprint to work from, showing detailed wiring diagrams, you can obtain it for 15 cents, to cover the cost of mailing, from Popular Mechanics Radio department, 200 E. Ontario st., Chicago, Ill. Specify blueprint No. 113.



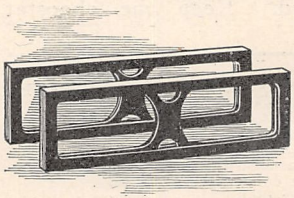
Above, Car Seat Lifted to Show Position of B-Batteries; Below Multiplug for All Connections

Forestalling Radio Troubles

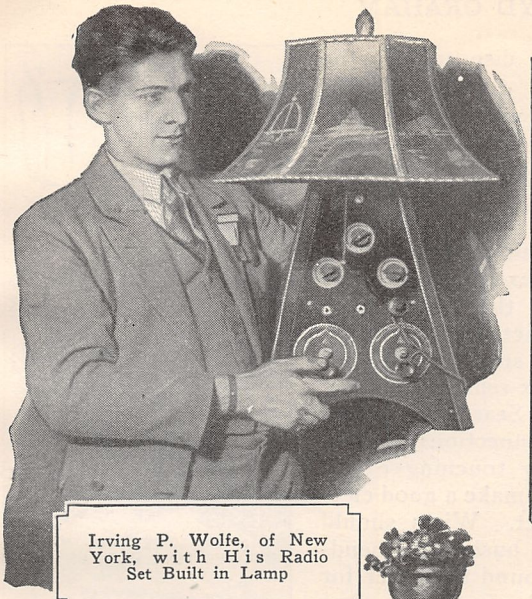
Every radio-set owner can be his own service man and save bills. The necessary equipment is very simple, and, if best results are to be maintained, it is a good idea to thoroughly overhaul the set at least twice a year. The following simple tools are needed: A small double-scale voltmeter, a screwdriver and a pair of pliers, a 2-in. camel's-hair brush, some pipe cleaners, such as are used to clean the stems of ordinary smoking pipes, and some fine sandpaper. Remove all dust from between the plates of the condensers with the pipe cleaners, and from other parts of the set with the camel's-hair brush. All terminals should then be tightened; corroded or dirty terminals should be loosened, and the wire and terminal thoroughly cleaned and brightened with the sandpaper. They should then be tightened until good contact is assured. The batteries should be tested by means of the voltmeter. The tubes should be turned on during this test. Dry-cell A-batteries should test 1.1 volts or more per cell, and the dry-cell B-batteries should test 17 volts or more per 22½-volt block, or 34 volts or more per 45-volt block. Storage A-batteries testing less than 1.8 volts per cell should be recharged. It is well to have several new tubes on hand for comparison with the old tubes. Old tubes that have lost their ability to give good results should be rejuvenated, if possible, or replaced with new ones. The aerial should be gone over to see that all connections are tight and that there are no breaks in the wires. If slack, the wires should be tightened. Last but not least, see that the ground connection is tight.

Non-Metallic Subpanel Brackets

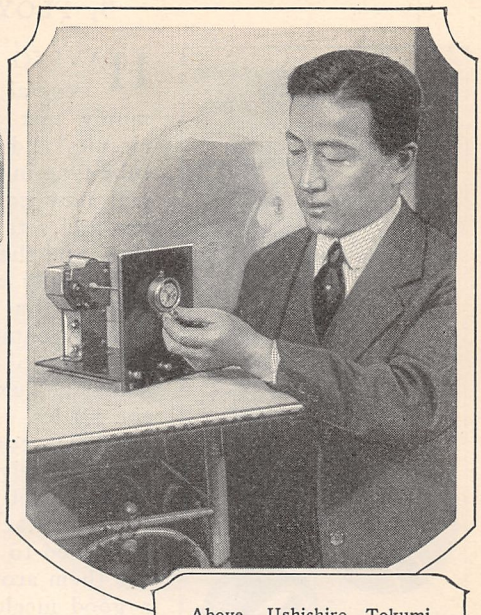
Non-metallic subpanel brackets are now offered to the radio builder. They are made of a strong insulating material, so that wires may touch them or be run through or near them without danger of short circuits and disturbing capacities. They are tested for structural strength, and the neat and efficient design with elimination of unnecessary metal in the fields of the various coils and condensers are of interest.



Here Are Radio's Latest Novelties

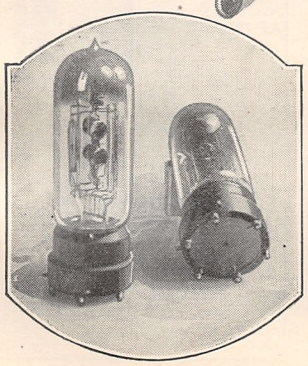


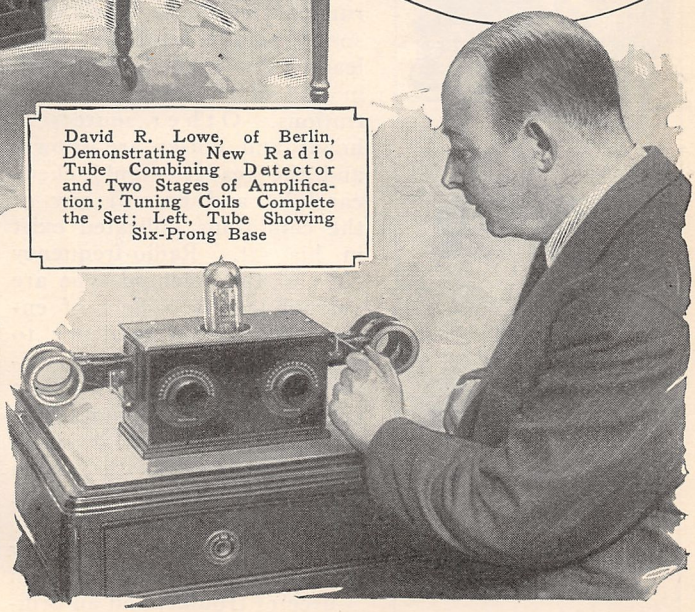
Irving P. Wolfe, of New York, with His Radio Set Built in Lamp



Above, Ushichiro Tokumi and His Radio Clock Switch That Can Be Set to Turn the Radio Set On or Off Automatically; Left, Complete Radio Set Built into a Table Which Harmonizes with the Other Furniture in the Room; the Loop Aerial Is Mounted on the Shelf under the Table, and a Cabinet Horn, Not Shown in the Photo, under the Instrument Panel or on the Table, as Desired

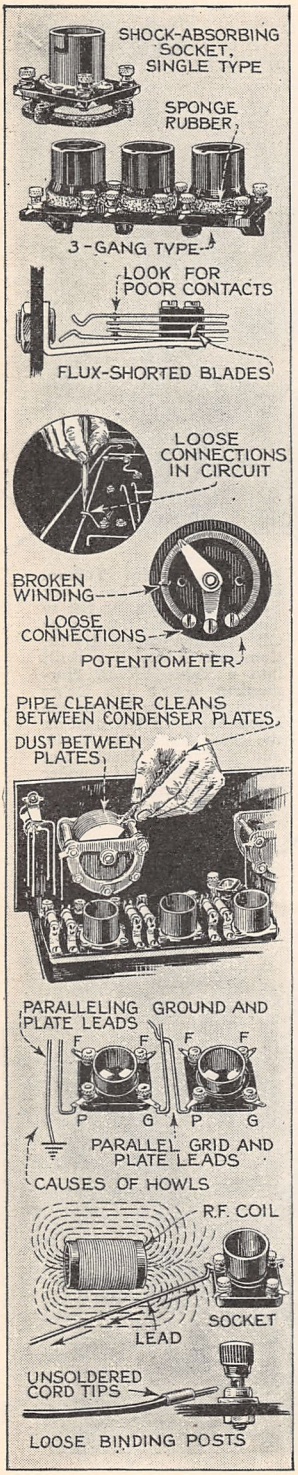
David R. Lowe, of Berlin, Demonstrating New Radio Tube Combining Detector and Two Stages of Amplification; Tuning Coils Complete the Set; Left, Tube Showing Six-Prong Base





What's Wrong with Your Set?

By FLOYD GRAHAM

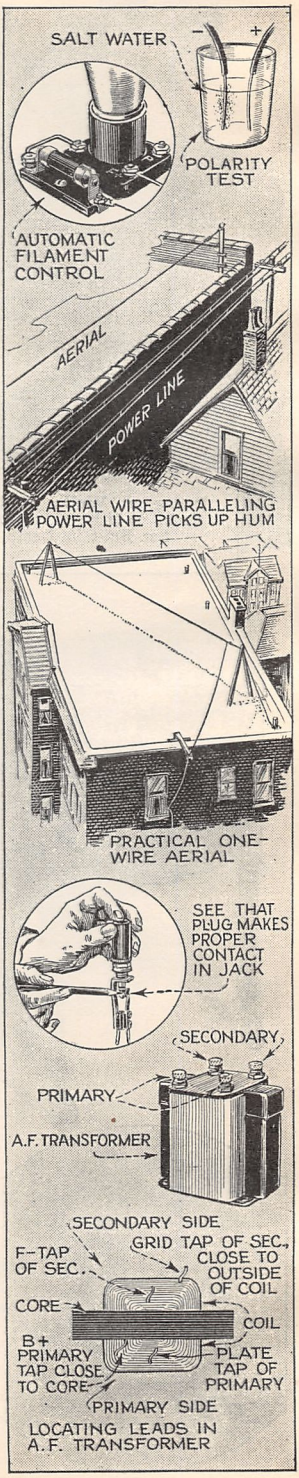


HAVING disposed of the general difficulties commonly met with in detector circuits and sets of the one-tube type in the July issue, we will now consider the amplifier and sets of the multitube type, and their troubles.

Carefully examine the jacks and see that the blades make proper contact, cleaning them so that no small particle of solder or flux remains to short the blades. Search all wiring for loose connections, as two wires merely touching each other do not make a good electrical contact. Wires should be joined to busbars by bending them around the latter for a good mechanical joint, then carefully soldered. A connection of this type offers a minimum of resistance to the current. To simply put two busbar wires together and solder them means not only mechanical weakness, but also high resistance, as solder alone is not a good conductor.

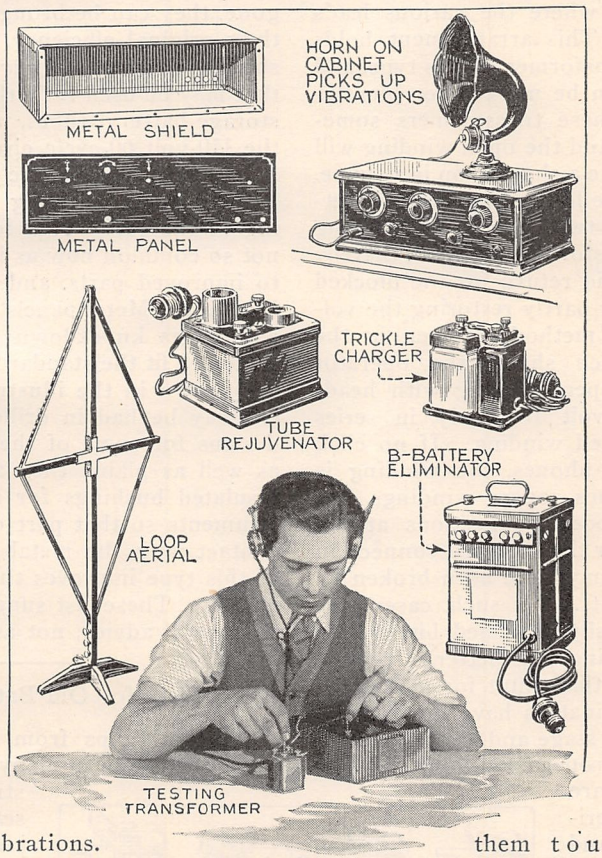
Ground and plate leads that run parallel cause howls, and so do parallel grid and plate leads. An example is shown in one of the marginal illustrations. Other sources of howls and noises are shown, and the reader should check carefully and note if any of the conditions indicated exist in his set. Radio-frequency coils of the solenoid type are surrounded by a field of energy that has a tendency to stray to any wires or instruments within reach. These coils should be kept at right angles to other coils or wires in the circuit, so that such fields will be kept within reasonable and safe bounds.

Dust between condenser plates is another common source of trouble, and an ordi-



nary pipe cleaner can be used to keep the plates free from it. Potentiometers are wound with very fine wire and breaks sometimes occur; if this happens, put in a new one. Keep all terminals tight. Loose cord tips mean high resistance resulting in losses; hence they should be carefully soldered or plugs of the screw-type used to reduce the loss.

Humming or microphonic noises in the horn are sometimes noticeable when the set is jarred or when someone walks across the room, causing vibrations which are taken up by the tubes, or the vibrations may be transferred from the set to the horn, if the latter stands on the same table. Sockets of the spring-suspension or rubber-cushioned type will prevent tubes from vibrating, and a new tube, just marketed, is especially designed to prevent this trouble. Its base is made up of two parts, separated by a tough sponge-rubber section that efficiently takes up such vibrations.



If an outdoor aerial is used, see that it does not parallel any high-tension lines and keep it as nearly at right angles to any such line as circumstances will allow. A well insulated, one-wire aerial of the type shown is ideal for radio reception and will give even better results than an aerial made up of a number of wires with more joints and other possibilities of poor connections. It is a good idea to make no soldered connection to the lead-in wire, but have the aerial and lead-in in one piece. It can be threaded through one end of the insulator from which the lead-in is to be taken and a turn or two made around the horizontal section of the wire to prevent slipping, the lead-in wire being continuous down to the set. Loop aerials that have high resistance give poor results. Even one of the best may be found defective in this respect. The only remedy is to exchange it for a good one or rewind it with a good grade of stranded loop wire, obtained at the radio store.

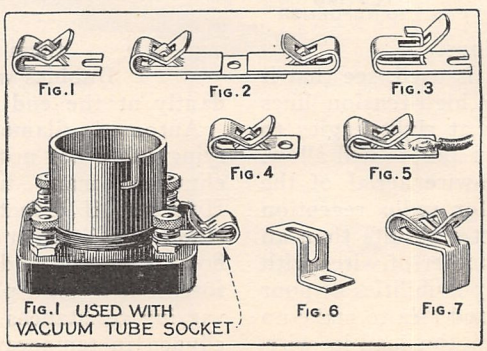
When connecting batteries watch the polarity carefully, for the battery current must go through the set in the proper direction or it will not work. Most modern battery terminals are plainly marked for polarity but if this marking is lacking or has become illegible, a simple test is the following: Add a pinch of salt to a glass of water, bare the leads from the battery and hold them in the solution without letting them touch each other. Bubbles will appear more abundantly at the end of the negative lead.

Automatic filament-controls for amplifying tubes are now in common use and eliminate many unnecessary rheostats. However, if defective, they will permit either too little or too much current to flow to the tube and cause trouble. Therefore, it is a good plan to have several of varying resistances on hand, that can be clipped in temporarily for test, until the one that works best is found.

Horn and phone plugs may not make good contacts with the blades of the jack, and a small flashlight is handy for examining such connections. Some of the earlier and cheaper plugs and jacks caused a great deal of trouble in this respect, so be sure yours are efficient.

In rare cases, a. f. transformer terminals are not marked, and the radio builder is at a loss to know which is which. A standard type of transformer is illustrated in its original case, and with the case removed to show where the various leads will be found. This arrangement holds good for any transformer of this type, and the terminals can be marked for identification. Also, these transformers sometimes burn out, and the open winding will immediately cause a sharp drop in volume. The break can be located by slightly wetting the tips of two fingers and placing one on each transformer terminal, thereby establishing a grid return for the blocked tube and thereby partly restoring the volume. A better method is given in the illustration, which shows the operator testing for an open winding with headphones and 45-volt B-battery in series with the suspected winding. If no click is heard in the phones, the winding is open. Sometimes open windings are caused by corroded connections at the terminal posts, or the soldered connection to the coil end may have been broken by turning the posts. In such cases, the break can be easily remedied but if it is deep in the winding, it is better to replace the transformer than hunt for a break.

B-battery eliminators have now passed the experimental stage and are practical if used under the proper conditions. A-battery eliminators are still in the experimental form and with a very few exceptions are not in general use. The little trickle charger shown in the illustration is very popular with users of dry-cell-tube sets, as it will keep the 4-volt A-battery charged and requires little attention, but is not adapted for charging larger storage batteries, although if a limited number of the large tubes are used, and the set is not operated over long periods, it can be used with good results.



Clips from Discarded B-Batteries Make Handy Connectors for the Experimental Hookups

No set will work well with old and defective tubes. If your tubes are of the type that can be rejuvenated, which your dealer will tell you, the little instrument for this purpose shown in the illustration should be part of your equipment. It is not expensive and if the tubes are not too far gone, they can be brought back to nearly their original efficiency. The instrument shown is one of the several similar types that may be used for either the dry-cell or storage-battery tubes, and works from the 110-volt 60-cycle circuit.

Last but not least, are you troubled with body capacity affecting the accurate tuning of the set? This form of trouble is not so common now as in the past, owing to improved parts, and the use of metal shielding. Metal panels are now available as well as knockdown metal linings designed to fit the standard cabinets. These are shown in the illustration. The panels may be had in drilled and decorated designs for some of the popular circuits, as well as plain; they are supplied with insulated bushings for mounting the instruments so that part of them comes in contact with the metal panel. Shielding of this type improves the performance of any set. These last suggestions are given as general advice, not as trouble data.

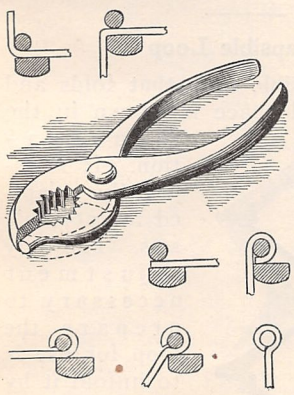
Uses for Old Battery Clips

Terminal clips from discarded B-batteries are useful in many ways in the construction of radio sets, and especially in experimental hookups. The clip can be drilled or filed as shown in Figs. 1 and 4 for use on vacuum-tube sockets as shown. Fig. 2 shows how two clips may be soldered to a narrow strip of brass cut from a third clip, a

hole being drilled through the center for a mounting screw. This double clip makes an excellent multiple connector. The clip in Fig. 3 is formed to make a coil mounting, handy in holding coils in accurate positions, and in Fig. 5 the clip is shown as a quick connector for loop-aerial leads. The tongue is first removed from the clip shown in Fig. 6, and the clip then drilled and shaped to make a permanent coil mounting. The same idea can be employed in making a subpanel bracket. A permanent connector for coil terminals and similar leads is shown in Fig. 7. An assortment of these clips will come in handy, especially to the experimenter who wishes to try out various circuits.

Wire Bender Made from Pliers

A handy wire-bending tool can be made from a pair of common gas pliers by grinding one jaw down to the shape indicated by the dotted lines in the illustration. The legs are separated and one of the jaws ground down to half its original thickness and to the shape shown by the full lines.



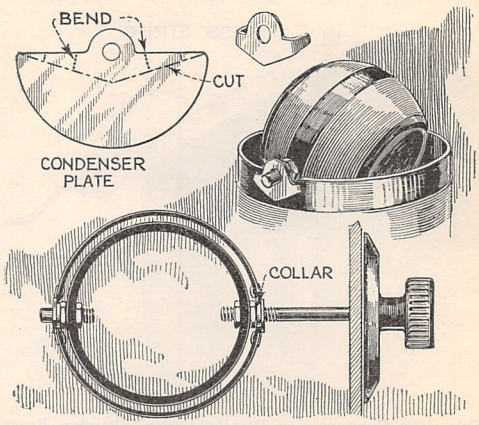
This should leave the tip 5/32 in. in diameter for a distance of about 3/16 in. The shaded portions in the detail drawings illustrate the tip of the tool after it has been assembled, and the position of the bus-bar wire during the bending operation. The upper sketches show the way to obtain a rounded or sharp bend, and the lower how to form a loop to go over a terminal post.

Stenographers Use Radio for Practice Dictation

Stenographers who wish to increase their speed in taking dictation are listening in on radio speeches sent out by the various broadcasting stations. Often the speech will appear in the newspaper so they can check their transcription.

Rotor Mounting Easily Made from Condenser Plate

Many radio experimenters find it difficult to mount rotor shafts on cardboard

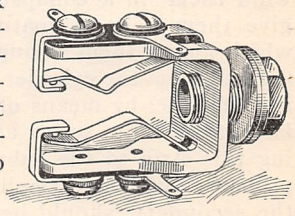


Mounting Collar for Rotor Unit Is Cut from Old Variable-Condenser Plate

tubing; this difficulty can be overcome by the method shown in the illustration. A rotor plate from an old variable condenser is cut along the line indicated in the upper illustration, and bent to the shape shown at the right. The prongs are thrust through the tube to hold the collar in place, and the shaft will then turn easily in the hole. The lower illustration shows the method of connecting the rotor shaft to the rotor unit. The dial is mounted on the end of this shaft in the usual manner. —Hubert A. Vachon, Haverhill, Mass.

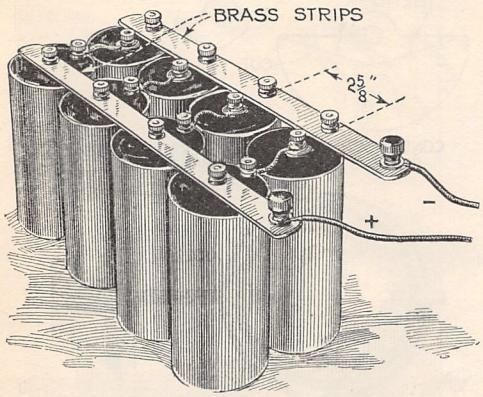
One-Inch Jack Needs Small Space

Jacks of novel design have lately made their appearance on the market. They are well made and take up very little room as they are only 1 in. long, lending themselves nicely to under-panel construction. The old type jack originated in telephone switchboard construction and has not before been refined for radio purposes. The new jacks are available in the regular standard types and take the ordinary horn or phone plug.



Metal Strip for Multiple Dry-Cell Connections

When several dry cells are to be connected in parallel, for multiple hookups of many cells, the battery connectors



Dry Cells Connected in Parallel Series, Showing Brass Strips Used for the Parallel Connections

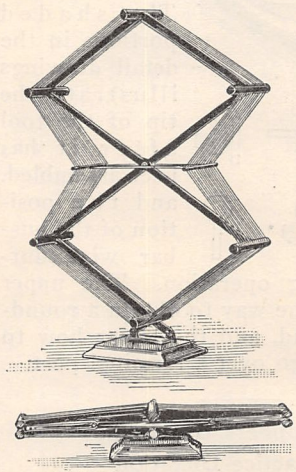
shown in the illustration will be found neat and handy. They are simply strips of brass slightly longer than the combined length of the cells set against each other in a straight line. As many 3/16-in. holes are drilled in the strip as there are parallel terminals to be connected; these holes are spaced 2⅝ in. apart. An old battery binding post is then mounted on the end of the strip. The cells are arranged in the correct position, the strip is placed over the battery binding posts and the nuts screwed on. This serves to hold the cells rigidly together and makes a solid connection.

Making Low-Loss R.F. Transformers

The best kind of r.f. transformers are cylindrical in shape, says the U. S. bureau of standards, after it had conducted exhaustive tests on all the different kinds of coils. To make them extremely low-loss, wind them on a collapsible cylinder and give them a good coating of collodion, which makes them strong. Then remove the coil from the cylinder and mount it on the subpanel by means of a ¼-in. strip of bakelite, a ½-in. screw at each end holding this strip to the subpanel. Now the primary, which is of smaller diameter than the secondary, should be fastened to the center of the strip in the same way as the latter is attached to the subpanel; only ¼-in. screws are used on these and they are tapped directly into the strips holding the secondary. The best location for the primary is in the center of the secondary, as the induction is then evenly distributed. The spacing between the primary and secondary and the number of turns of wire on the primary determine selectivity and volume of signals, and the ratio of the number of turns between the primary and secondary should be about 1 to 10. The larger the primary is, both in diameter and in number of turns, the broader the set will tune and the more volume it will have. This is advantageous for locations quite some distance from broadcasting stations, but in large cities, such as Chicago, it is necessary to have selectivity, which is gained by decreasing the diameter and the number of turns of the primary. If .00035-mfd. condensers are used to tune the secondaries, the latter should have about 54 ft. of wire, which means about 108 turns on a 2-in. diameter. Primary coils, 1½ in. in diameter, having 11 turns, have been found very satisfactory with this size of secondary.

Collapsible Loop

A new collapsible loop that folds and unfolds in small space is shown in the illustration. It is especially adapted for portable sets. The only adjustment necessary to prepare the loop for use is to unfold it by pulling at the top. It will hold any adjustment with all wires taut, and pivots on a hardwood base. When not in use it can be placed in a drawer, or pushed into the lid of a portable set.



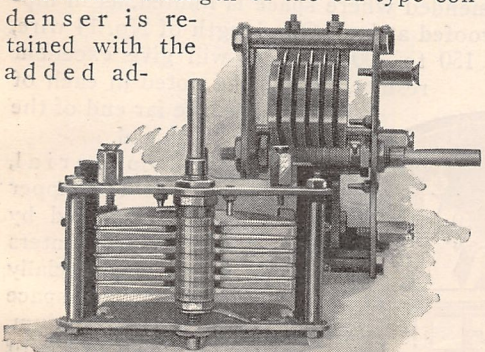
¶Howling is often caused by the plate and grid leads running parallel and too closely together.

Finishing Radio Cabinet

Many radio fans can boast of as fine a homemade set as can be bought anywhere, but most of us are not well satisfied with the appearance of the homemade radio cabinet. Of course, we have sanded and finished it with care, but it does not quite come up to the manufactured product, especially of the two-tone type. The two-tone effect can be obtained easily and at little cost as follows: If the cabinet has already been finished take off the finish with varnish remover. Then sand the cabinet well and, with a small brush, paint the parts you wish to be lighter-colored with white shellac. Sand again after the shellac has dried, until the treated parts are level with the rest of the surface and smooth. Finish with a coat or two of some good varnish stain and the pleasing result will more than repay you for the trouble. If a piano finish is desired afterward, it is advisable to add a coat of clear varnish and allow it to stand six days, then rub down with rottenstone and oil to the required brilliancy.

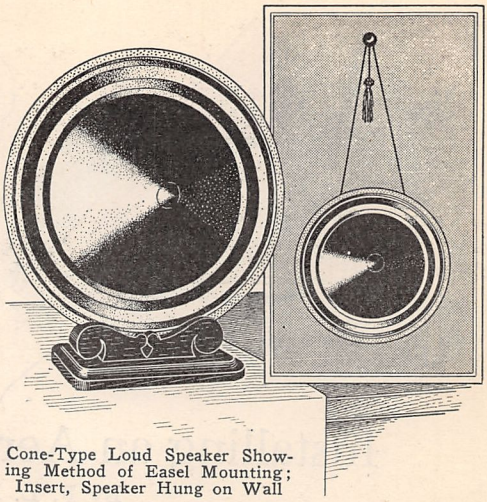
Variable Condenser Has Plates That Are Wedge-Shaped

A new straight-line-frequency condenser differs from the usual design in that the plates are wedge-shaped. The mechanical strength of the old-type condenser is retained with the added advantage that there are no widely extended rotor plates to cause crowding of parts on the usual 7-in. panel.



Side View Showing Wedge-Shaped Rotor and Stationary Plates

A moist ground is the best as it offers the least resistance.



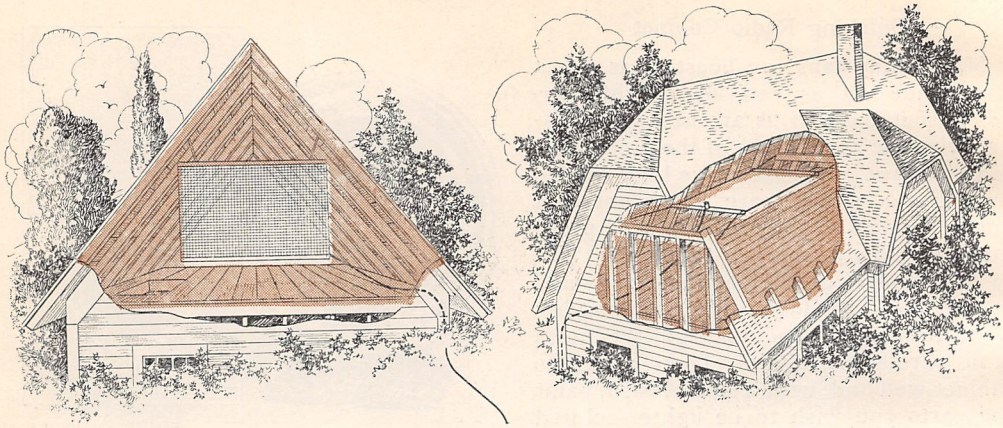
Cone-Type Loud Speaker Showing Method of Easel Mounting; Insert, Speaker Hung on Wall

Cone Speaker for Wall or Easel

The cone speaker shown in the illustration is one of the late arrivals on the market, and is featured by its adaptability for mounting on an easel base or hanging on the wall, to which end it is provided with a detachable base and a silk hanging cord. When suspended on the wall, it decorates the room and is less subject to the vibrations encountered by the table type of speaker. The seamless diaphragm is replaceable at small cost, and is claimed to be immune to atmospheric effects. It has a mahogany back which acts as a sounding board, increasing the volume.

Hints on Connecting Aerials

When building the aerial keep the connections as few as possible. Try to have the aerial wire in one piece; this can be done by threading the wire through the end of the insulator at the lead-in end, taking two turns around the horizontal wire and continuing on down with the same wire for the lead-in. Keep the horizontal part of the aerial as straight as possible, without bends. This also applies to the lead-in wire; do not try to fit it around corners. When planning the aerial, see that the lead-in wire will reach the set by the shortest way. The ground wire should also be as short as possible. For these short connections it is necessary to carefully consider the location of the set in the building and of the aerial on the roof.

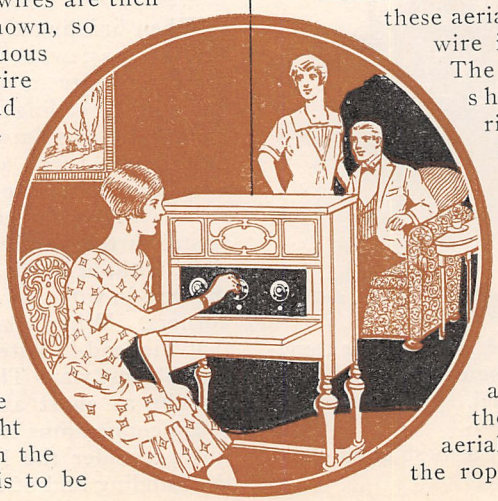


Installing an Aerial in Your Attic

By F. L. BRITTIN

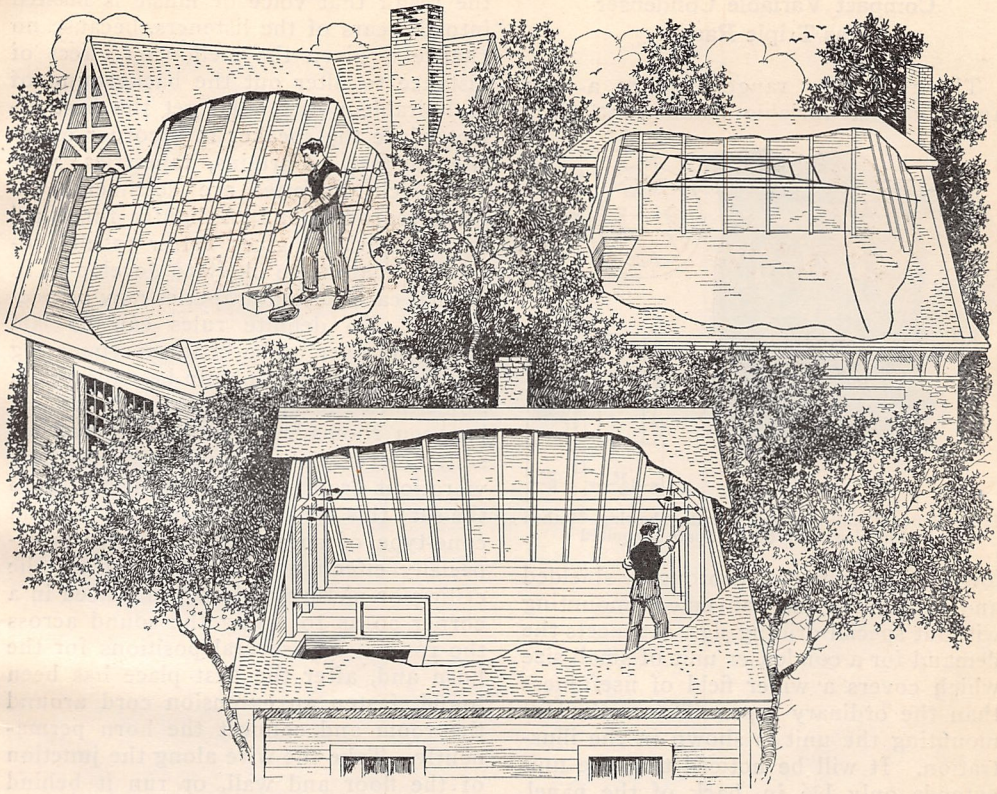
ATTIC aerials, if properly constructed, give almost as good results as the elaborate outdoor types and are easier to build. No lightning arrester is required for them and another advantage is that they are protected from soot and corrosion due to smoke and weather conditions

When selecting the type of attic aerial to use, it is necessary to take into consideration the size and shape of the attic. The illustrations give the builder a number of different types and methods of installation, all of which are good. We will first consider the end-to-end type, shown in the lower illustration on next page. It consists of four wires run the full length of the attic and connected to insulators at each end. Jumper wires are then soldered across, as shown, so as to make one continuous wire. The lead-in wire is soldered to the end indicated by the worker's hand, and is connected just inside of the insulator; from this point it is taken down to the set. The lead should be of insulated No. 14 wire and can be run down between the partitions and brought out to a wall plate in the room where the set is to be located. Brass wall plates are now available for this purpose, and some are equipped for both the aerial and ground connections. The aerial and ground leads from the set are then provided with small plugs which are inserted in the wall plate, making simple and efficient connections that eliminate long unsightly wires running around the room.



At the upper left in the same illustration is shown a similar type of aerial consisting of one continuous wire fastened to the rafters with porcelain insulators of the split-unit type. This aerial is recommended where space is limited, as in hip-roofed attics. One length of No. 14 wire, 150 to 200 ft. long, will give excellent results. It will be noted in each of these aerials, the far end of the wire is left dead.

The flat-loop aerial, shown at the upper right, is preferred by some experimenters as it is especially useful where space is at a premium. Two lengths of clothesline or light rope are strung across the attic from corner to corner, and are tied together at the crossing point. The aerial wire is fastened to the ropes, as shown, and is



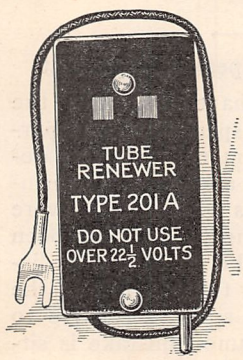
tied firmly at every point where it touches the rope. The inner end is the dead one and the outer end is connected to the lead wire to the set. The turns should be spaced about 1 ft. apart.

The curtain and mat types of aerial, shown in the colored illustration, are very popular. The one at the upper right is a manufactured type built in the shape of a large mat, and consists of numerous small wires between two thicknesses of heavy paper. The wires are bound with metal strips at each end and the lead wire is taken from one of these strips. The mat is suspended from the rafters by means of short ropes. The aerial at the left is homemade and of the curtain type. It consists of a section of copper screen with wood strips at top and bottom. The lead-in wire is soldered directly to the copper screen.

Do not neglect a good ground for the set; this is fully as important as a good aerial, and one of the best grounds obtainable is a cold-water pipe located as near the set as possible. Use a ground clamp and see that the pipe is free from rust or paint at the point where the clamp is to be fastened to it.

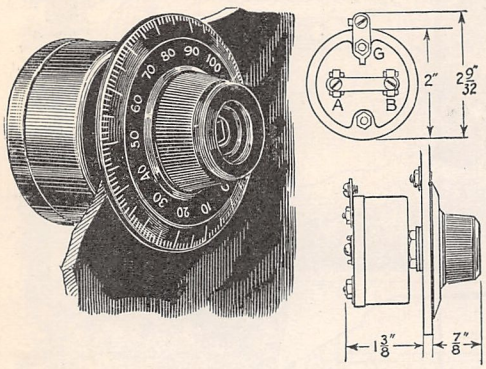
Tube Rejuvenator Operates from Radio Batteries

A tube booster, or rejuvenator, that operates from the batteries of the radio set instead of the lighting socket, is now available. This makes tube boosting instantly possible wherever the set may be, at the summer camp, on a farm or in the city. The direct current from the batteries is claimed to have greater efficiency, due to the absence of periods that tend to cool the filament between the "flashing" of the tubes at the high voltage.



Compact Variable Condenser Has Triple Range

Three capacity ranges feature a new and compact variable condenser. This



Triple-Range Condenser and Details Showing Method of Mounting, and Small Space Required

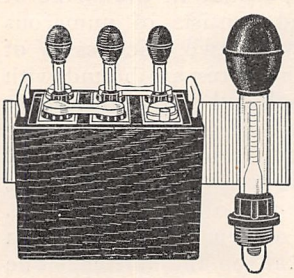
low-loss instrument is thoroughly shielded and is adapted for convenient mounting without special drilling jigs. It meets the demand for a condenser unit of small size which covers a wider field of usefulness than the ordinary type. The method of mounting the unit is shown in the illustration. It will be noticed that the unit extends only 1⅜ in. back of the panel. The end view shows three terminals, A, G and B; connections to terminals G and B give a range equivalent to an ordinary 11-plate condenser, to terminals G and A, the equivalent of the ordinary 23-plate condenser, and to terminals G and AB (using busbar), the equivalent of the ordinary 43-plate condenser. Terminal G is in contact with the condenser case or "shield," and may be grounded to eliminate body capacity.

Position of Loud Speaker Important

A number of tests have shown that the position of the loud speaker in any particular room or apartment has a very decided influence on its acoustical performance. In several cases where results were not satisfactory and the difficulty had been blamed on the set, the trouble was discovered to lie not in the set, but in the location of the loud speaker relative to the listeners. A common mistake is sitting too near the speaker, or placing the horn too near the set or on top of it, with the result that voice or music is blasted into the ears of the listeners, because no chance is given the mellowing effect of distance to filter out the background of undesirable noises. To get the best effect, place the speaker in a corner opposite the set. Curtains, tapestries, rugs and thick draperies are detrimental to good reproduction. A lightly furnished room invariably gives better results, although echoes are likely to develop in it. In that case certain draperies may be necessary. No definite rules can be laid down, however, and a little experimenting will be necessary to obtain best reception. Sometimes the mere parting of curtains between rooms will give the desired result. Never place a loud speaker where vibrations from it can be transmitted to the set; this applies to both the horn and cone-type of speaker. The latter is especially effective if suspended from the ceiling or picture molding, or placed in a corner so as to throw the sound across the room. Try several positions for the horn and, after the best place has been found, fasten an extension cord around the room and connect the horn permanently. Take the wire along the junction of the floor and wall, or run it behind the picture molding where it is hidden.

Permanent Hydrometers Simplify Battery Testing

A hydrometer mounted permanently in each battery cap takes the danger to rugs and floors out of this method of battery testing and is always ready for use. The



units are available in sets of three and can be adjusted to fit in any battery. The reading of each cell may be taken by compressing each bulb in turn and returning the electrolyte to the cell after the reading has been taken. As the instruments are not withdrawn from the cells, there is no danger of spilling the corrosive solution, as with the common type.

Tool Kinks for Radio Builders

By ROBERT S. KRUSE

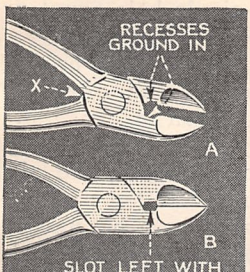


FIG. 1

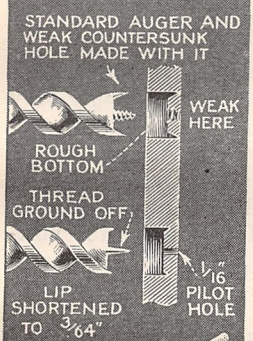


FIG. 2

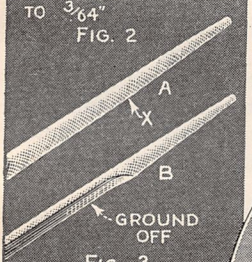


FIG. 3

FIG. 4

THE kinks and suggestions given in this article are not intended to be strikingly novel but simply to point out to the radio builder some handy ways of making the tool fit the job.

When wiring radio receivers, or anything else, wherein "annunciator" wire is used, there isn't a doubt that the handiest cutting pliers are the so-called "diagonals," which have a very pleasing way of reaching into close corners and making the cut at exactly the right place after the wire is in position. Unfortunately these pliers have no convenient place in which the rubber-wound wire can be squeezed to break the insulation before stripping it from the wire. A simple way to provide such a surface is shown in Fig. 1, 3/16 in. of the cutting edge nearest the hinge being sacrificed. The flats are formed by grinding, as shown at A. When the pliers are closed, as at B, the slot should just allow the smallest size of wire to slide through after the insulation has been stripped. Usually the smallest wire is No. 22. Since the recesses should be reasonably square-cornered and the steel is usually too hard to file, it is convenient to finish the cut with a small slip of carborundum stone. If this is not available, it can be done with a small file plus oil and carborundum powder; this may ruin the file, so if a worn-out file can be used so much the better.

FIG. 5

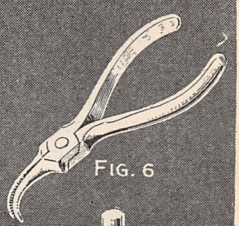


FIG. 6

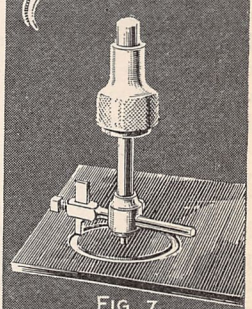


FIG. 7

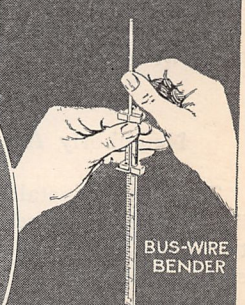


FIG. 8

When assembling radio sets or other light devices on a wooden baseboard, it is frequently necessary to countersink a round-headed machine screw in it, usually with a washer under the head. The hurry-up amateur way of doing this is to use an auger, with the result shown in Fig. 2, a weak uneven bottom being obtained that will not support the machine screw and washer because the edges are almost cut through.

A bit can be prepared for this work by grinding off the threads of the lead screw and shortening the lips to 3/64 in., as shown in the lower sketch. Care should be taken to leave the guiding spur true. In using a bit of this type, a 1/16-in. pilot hole is first made with any type of drill, after which the auger will follow exactly. When the hole has reached the right depth, take one turn without feeding, and the bottom of the hole will be made smooth.

Sooner or later one has to ream holes in insulating material; some of this will not stand up under the reamer and the only remedy seems to be to work with a tapering round file, which, however, persists in jamming in the hole. Fig. 3 shows a way of grinding such a file so that it will be more easily handled. The first third of the file is left round and the rest ground off on one side. This may sound foolish, but is a great help.

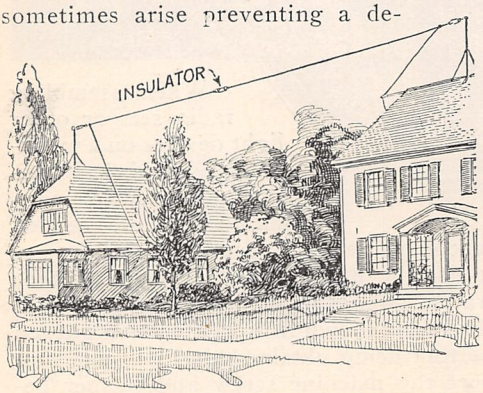
A good countersink tool for insulating materials is shown in Fig. 4, and is made by grinding an ordinary twist drill to a long point. Flat-head screws are supposed to have their heads made to a standard angle, but this is not true with the smaller brass screws. It is best to make the point of the drill a little too sharp; very little clearance should be ground off to prevent hogging. This sort of countersink keeps the chuck far enough from the work to permit a clear view which is important because a single hole countersunk too far will often spoil the job.

The difficulty of judging the proper depth of the countersink can often be avoided by the kink shown in Fig. 5, although it is good only when the insulating parts are of uniform thickness, the pin acting as a depth guide. If the panel is of rubber, the pin must be a bit undersized to prevent seizing. A countersink of this type can be ground from an ordinary twist drill.

When drilling or countersinking holes, stand directly above the work in the position shown in the photograph. Keep the drill straight up and down and apply only sufficient pressure to insure a good cutting action. Excessive pressure will break out the underside of the material; a block of wood under it will prevent this and insure a clean hole. Large holes for voltmeters often try the patience of the amateur, but by using an expanding bit of the type shown in Fig. 7, this part of the work will be found very simple. The bus-wire bender shown in Fig. 8 is a new and useful tool, saving time and wire, as it measures the wire to the length of each bend, and after a little practice surprisingly quick and accurate work may be done with it.

Neighborly Aerial Installation

The aerial installation shown in the illustration has several advantages where two neighbors have the same problem to solve. In suburban localities difficulties sometimes arise preventing a desirable location of the aerial for best results. Everyone wishes to run his aerial in the direction best suited for the greatest number of broadcasting stations, and if the houses are facing north or south, for instance, the limited width of the average lot will not permit a very long east-and-west aerial. With a little co-operation this difficulty can be overcome, the single-wire aerial being divided in the exact center by an insulator.



Divided Aerial Showing the Position of the Insulator Midway between the Two Houses

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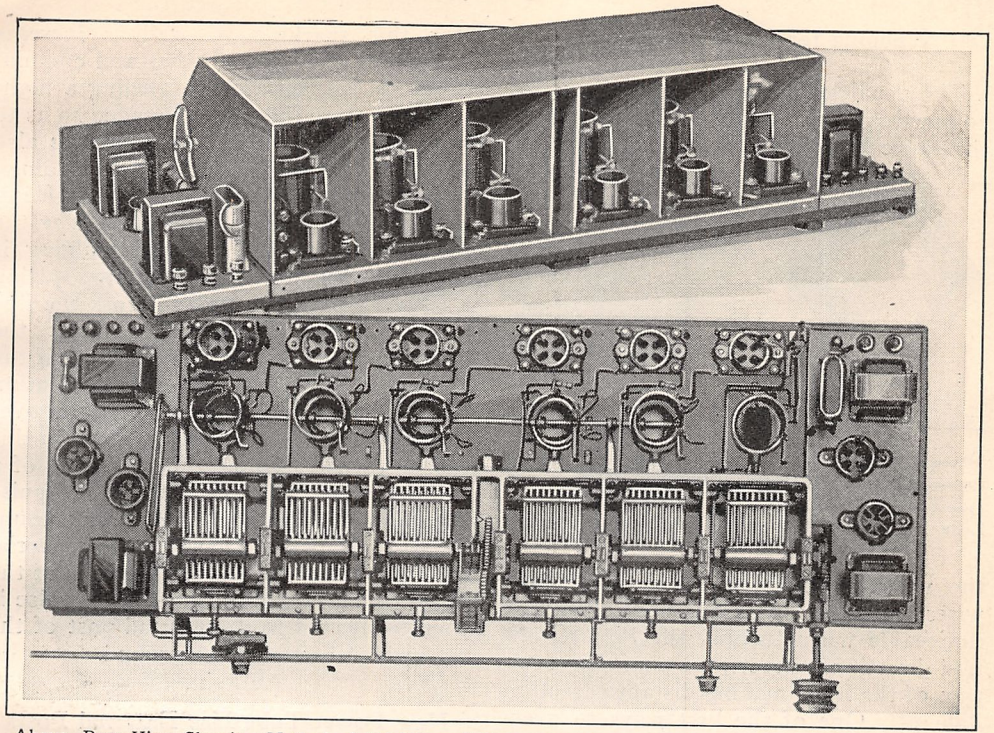
Ten-Tube, Six-Condenser Set Has Single Control

We are familiar with single-control sets of the five-tube variety, but when ten tubes are placed under a single control our curiosity is aroused. The photos show the arrangement of a well-designed receiver of this type. Five stages of tuned r.f. amplification, a tuned detector, and



Above, Rear View Showing Method of Shielding; Below, Shield Removed Showing Gauged Condensers and Rotating Mechanism

four stages of low-ratio a.f. transformer-coupled amplification are used.

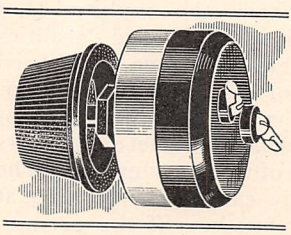
The five tuned r.f. stages and the detector stage are well shielded and are all tuned by variable condensers operated from a single shaft. A small coil in the plate circuit of each stage, coupled with the succeeding grid circuit, is rotated whenever the main tuning control shaft is turned, and automatically maintains each stage of the amplifier at the best coupling point as the wavelength is varied. All of the rotor coils are mounted on one shaft, which is in turn driven from the main condenser shaft by a link mechanism. Special one-to-one ratio a.f. transformers, with unusually large iron section and winding space, are used. An output transformer to match the loud-speaker units, which are supplied with the set, is incorporated in the receiver.

With the one tuning dial it is possible to run over the entire broadcast range of the receiver in less than a minute, and to note the nature of the program from every station within range at the moment.

The frame of the six-unit variable condenser serves as the chassis of the set itself and within this frame are mounted the die-cast stators of the six condensers.

The set is available in several antique models of period type, each cabinet containing a battery compartment, and is equipped with dual loud speakers covering the entire musical range. A pilot light is mounted within the cabinet to illuminate the dial, and this light is controlled by the switch on the panel which places the set in operation.

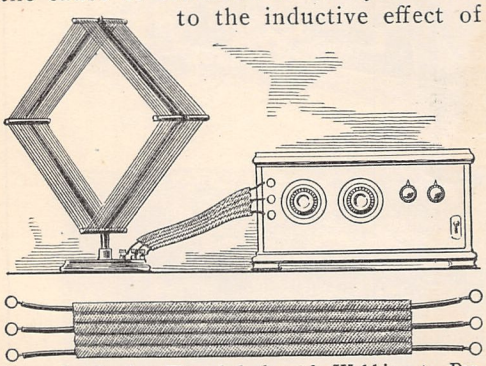
Dustproof Case on Rheostat



A bakelite and polished-nickel case completely incloses this new rheostat. Its moving parts are thoroughly protected from mechanical injury or accumulation of dust and the instrument takes up very little room behind the panel. Mounting requires the drilling of only one hole for the center bushing and locking nut.

Webbing for Loop Connections

The usual loose and haphazard way of connecting loop aerials to sets has been the cause of considerable annoyance due to the inductive effect of



Loop Leads Are Threaded through Webbing to Prevent Induction and Improve Appearance

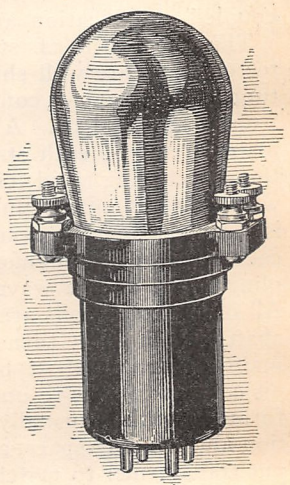
the varying distances between the lead wires. This condition has been especially noticeable when turning the loop to obtain directional effects, the changing position of the leads making distant reception difficult. One of the best ways to overcome this inductive disturbance is to obtain a piece of cotton webbing similar to that used in trunk straps. Remove the two outside cords and, if the loop is of the three-tap type, also the center cord. The loop leads of No. 22 copper wire are then threaded through the conduits thus formed. For best results the terminals should be connected to a binding-post strip fastened to the base of the loop, leaving enough slack in the flexible wires so that the loop can be rotated.

Preventing Interference in Congested Districts

Interference from the multitude of causes present in the crowded localities of large cities has for some time been the main topic of conversation in radio-engineering circles. Motors used for operating the blowers of home oil burners cause quite a bit of this interference. The trouble is usually caused by sparking at the commutator brushes; if the commutator is rough, it should be smoothed with a piece of fine sandpaper and the brushes reset correctly. A large by-pass condenser across the brushes will do no harm to the machine, and will help to stop this sparking, as well as increase the efficiency of the brushes and commutator. If the aerial is paralleling a high-tension line, it should be changed so as to run at right angles to the line; this also applies to street-car and elevated lines. Often humming sounds that are difficult to locate, are found to be caused by the d.c. lighting circuit. If the building is supplied with a d.c. source, try putting a large by-pass condenser across the line at the main switch. Disconnect the ground wire from the receiver, and, if the hum has disappeared, it is an indication that the interference is coming in over the ground wire. The best remedy in this case is to use a counterpoise instead of a ground wire. An effective counterpoise can be made by running the same amount of wire you now have in your aerial around behind the picture molding of the room. The lead from the counterpoise is then connected to the ground post of the set instead of the usual ground.

New Power Tube Has External Posts

Power tubes having external binding posts for the necessary battery connections, eliminating wiring changes in the set, have now appeared on the market. These tubes fit in the standard sockets and the extra C and B-battery connections greatly simplify the installation. The two binding posts are connected if the proper C and B-batteries are already in the set. Power tubes, when used in the last stage of a.f. amplification, prevent overloading and distortion.



¶When several low-powered stations are difficult to separate and bring in clearly, increase the detector and amplifier filament voltage slightly.

BRING IN THOSE DISTANT STATIONS

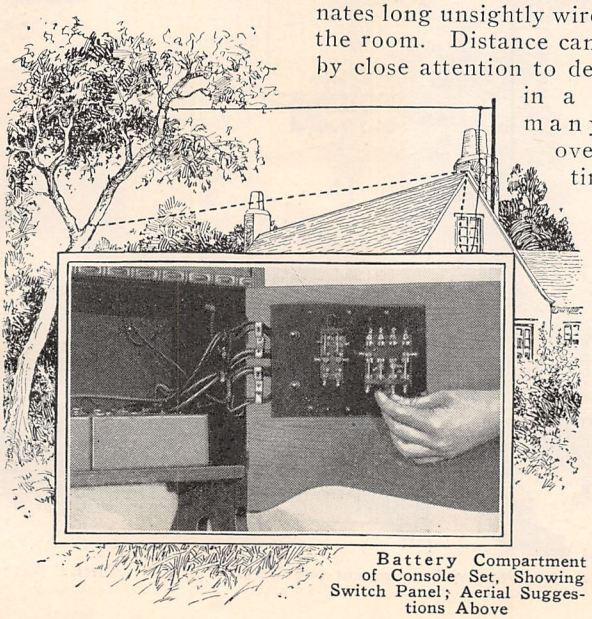
By ROBERT H. KIRBY

THE thrill of bringing in a really distant station comes only to those who make possible the conditions favorable to long-distance reception. Now that the ideal radio weather will soon be with us, it is high time to look over the radio set, aerial and ground connections and see what can be done to obtain the very best results.

We will assume that the receiving set is a good one, not necessarily a large set, but one that is well designed and carefully built. A well-built three-tube set will often step out and bring in surprisingly distant stations if given a chance; however, the larger sets have a decided advantage, enabling them to overcome conditions smaller sets cannot cope with. Good tubes and fresh batteries are, of course, of first importance; if the tubes have been in use for some time, they may need rejuvenating or, if beyond such help, must be replaced with new ones.

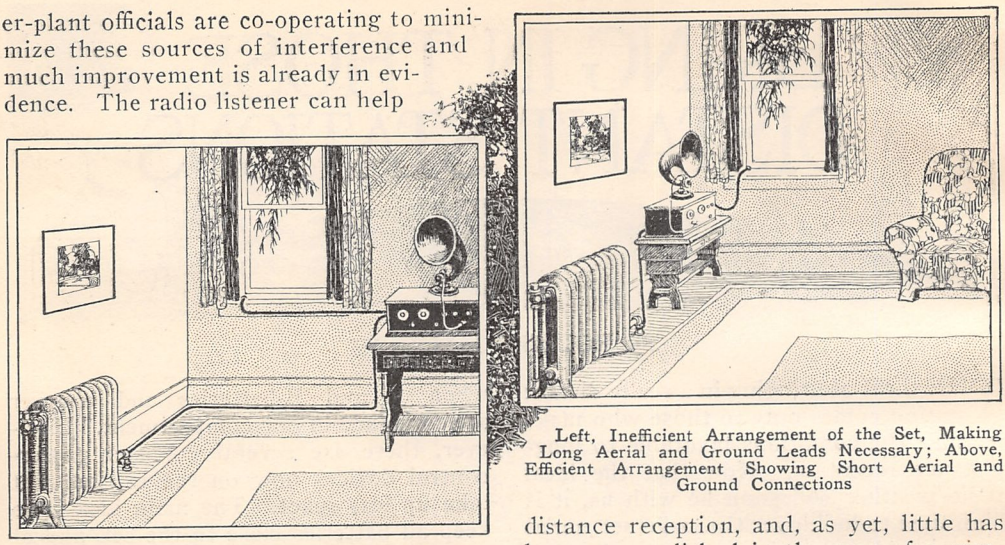
Short battery leads are important; photos are shown of typical installations to give the reader an idea of the right and wrong way of placing the batteries. The switchboard on the door of the console cabinet is a good idea for an elaborate installation when A and B-batteries and charger are combined in one compartment. However, there are several compact power-control devices now on the market that take up less space. The main idea is to keep all batteries close to the set, and at the same time out of sight or as nearly so as possible. Note the untidy arrangement in the photo showing the batteries on the floor with long straggling leads running to the set; an installation of this kind cannot be expected to give maximum results. The same set is shown at the right with the batteries placed on a shelf under the table, making possible short battery leads and certainly a neater appearance.

Proper placing of the set in the room, so as to obtain short aerial and ground leads, as shown in the illustrations, often results in greater efficiency, and eliminates long unsightly wires running around the room. Distance can only be obtained by close attention to details. If you live in a city, there are many obstacles to be overcome and sometimes they make distant reception impossible; however, these conditions are not common and only exist in certain localities. One sketch shows a busy city street and the various points from which interference may come. City and pow-



Battery Compartment of Console Set, Showing Switch Panel; Aerial Suggestions Above

er-plant officials are co-operating to minimize these sources of interference and much improvement is already in evidence. The radio listener can help



Left, Inefficient Arrangement of the Set, Making Long Aerial and Ground Leads Necessary; Above, Efficient Arrangement Showing Short Aerial and Ground Connections

himself under these conditions by making sure his aerial does not parallel any such power lines, and notifying the officials when any particularly annoying interference is present in the neighborhood.

Atmospheric disturbances, known as static, are nature's great obstacle to long-distance reception, and, as yet, little has been accomplished in the way of a remedy. Static is present the greater part of the year, and is at its lowest ebb during the winter months. It knows no wavelength and when the so-called static-interference level is above the signal strength of the transmitting station, the receiver is cut off completely. This effect is illustrated by the beam of light cut off by the intervening wave in one of the drawings; the static waves offer the

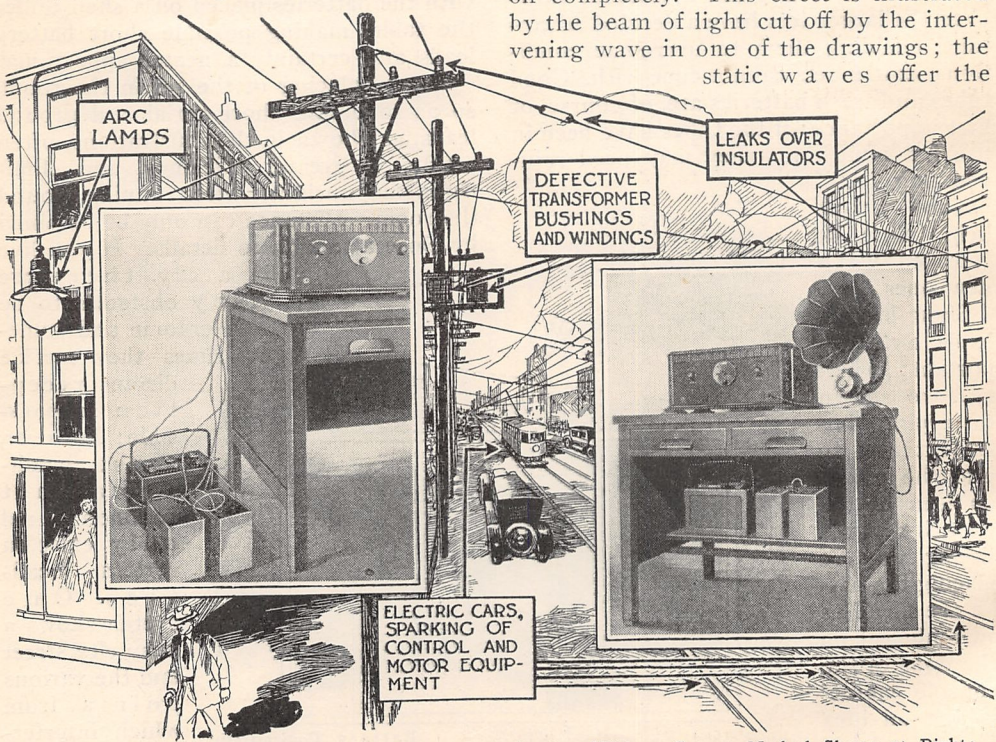
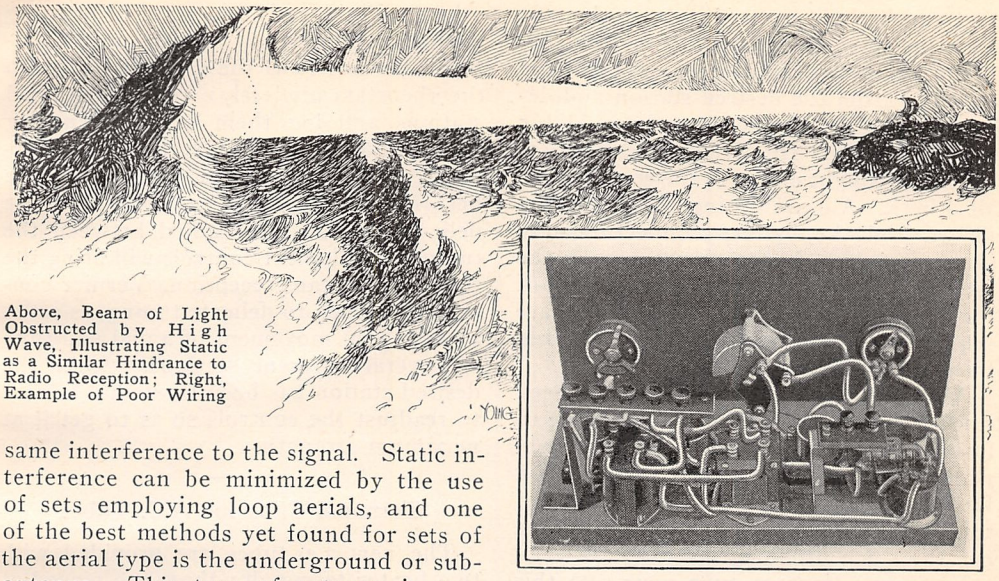

ARC LAMPS
LEAKS OVER INSULATORS
DEFECTIVE TRANSFORMER BUSHINGS AND WINDINGS
ELECTRIC CARS, SPARKING OF CONTROL AND MOTOR EQUIPMENT

Photo at Left Shows Poor Battery Arrangement and Careless Wiring; Correct Method Shown at Right; Sketch Indicates Sources of Interference in the Average City

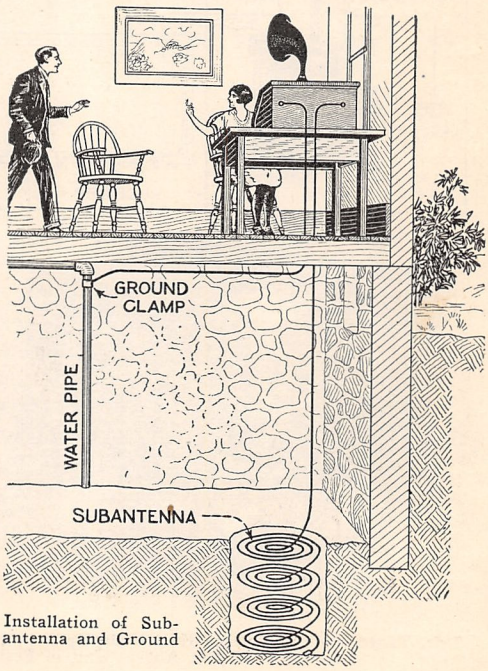


Above, Beam of Light Obstructed by High Wave, Illustrating Static as a Similar Hindrance to Radio Reception; Right, Example of Poor Wiring

same interference to the signal. Static interference can be minimized by the use of sets employing loop aerials, and one of the best methods yet found for sets of the aerial type is the underground or subantenna. This type of antenna is now available and comes ready to install, either in the yard or under the building. The results are much better during the static season with this subantenna, and the signal strength is about the same as that obtained with an outdoor aerial. The illustration shows the method of installation in a hole 3 ft. in diameter and about 4 ft. deep. The antenna is coiled in layers and the earth filled in between the coils up to the surface level.

The rear view of a set showing the terrible example of bad wiring, is an actual photo; indeed, the photo flatters it. No one can expect to get distant stations with a receiver of this kind; it is a marvel that it works at all. Some radio builders are apparently satisfied if the set brings in signals, but there is little gained by buying good parts and then throwing a bunch of wire around them. Anyone can build a neat and efficient radio set without even soldering a joint if a little pains is taken. If a soldering iron is not available, neat and good work can be done with busbar wire and a pair of long-nosed pliers, or special wire-bending pliers. Loops may be made over the various terminals, good electrical connections obtained and the wiring run direct to each instrument.

For the distance or DX fan, there are several ways by which he can extend his range and bring in stations he has not heard before. The addition of a stage of tuned radio frequency will often give surprising results in better selectivity, range and volume. There has long been a demand for a self-contained independent unit of this type and several such units have lately appeared on the market. The one shown in connection with this article may be obtained either as a finished unit, as shown, in a case, or as a knockdown kit



Installation of Subantenna and Ground

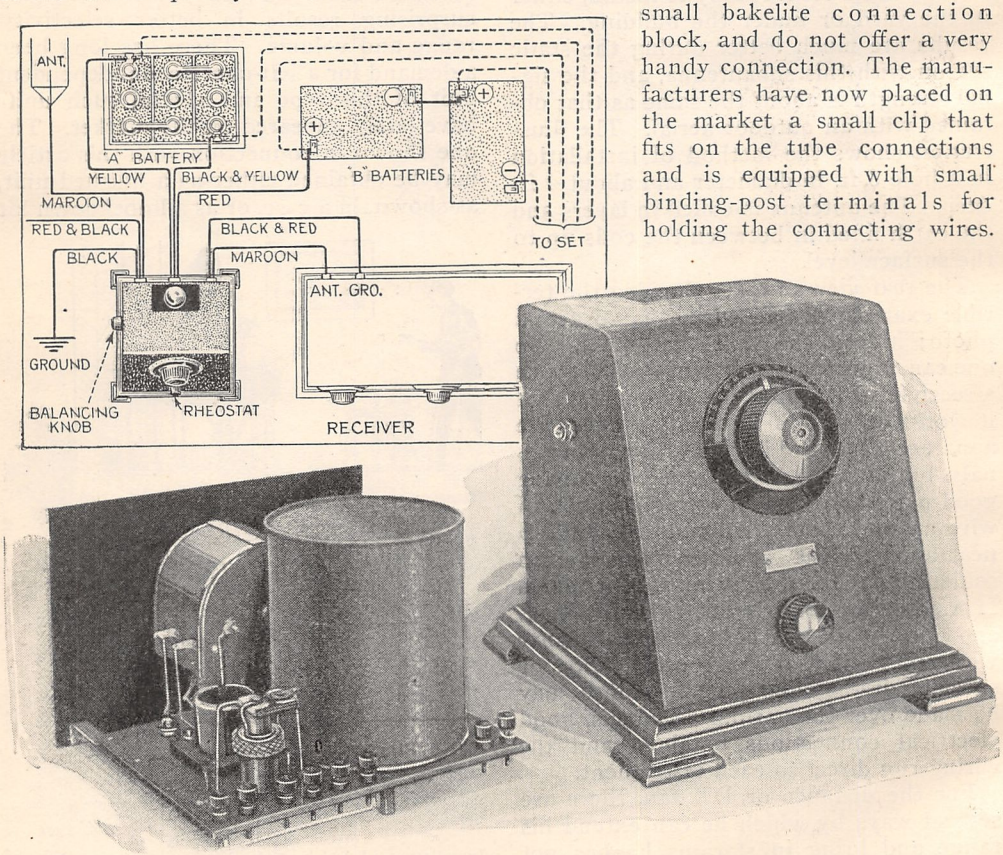
that can be built up as shown at the left. This instrument is simply connected between the aerial and the set; it takes the impulses from the desired station and delivers them to the receiver in a highly amplified form. In effect, the station selected is brought closer to the exclusion of all others. All connecting wires are furnished and the battery connections are given; no alterations are necessary in the set, and the unit can be placed on top of the receiver. No additional batteries are required, as the instrument is operated from the same batteries as the set.

After the set and installation have been carefully checked and everything done to insure maximum results, there is one remaining factor to be considered before a far-distant station can be brought in; this is the personal factor, and everyone has the same problem.

You must learn to tune your set; this comes more quickly to some than to others. Patience is necessary in learning to tune a receiver and practice makes perfect. Do not twirl the dials and turn up the rheostats aimlessly; begin with local stations and log them carefully, noting the position of the rheostats for best results. The same relative positions will be best for the far-away stations, and the delicate balance maintained between the tuning and filament controls will bring the reward of distant reception. Vernier controls add much to delicate tuning, as often a very slight movement of a dial will tune in several different stations. After the desired station has been located, it is easy to readjust the controls so as to get it at maximum strength.

Terminal Clips for A.C. Tubes

The new a.c. tubes are provided with two heater terminals; these are placed at the top of the tube, protruding from a small bakelite connection block, and do not offer a very handy connection. The manufacturers have now placed on the market a small clip that fits on the tube connections and is equipped with small binding-post terminals for holding the connecting wires.



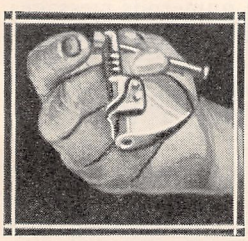
Left, Tuned Radio-Frequency Unit Made Up from Knock-Down Kit; Right, Ready-Built Unit of the Same Type; Above, Unit in Position with Battery Connections

BORE HOLES AROUND VOLCANO TO STUDY ERUPTIONS

In the belief that changes in temperature will be more easily determined and thus the likelihood of eruptions foretold, scientists, under the direction of Dr. Thomas A. Jaggar, have bored a number of holes ten feet deep around the crater of the Kilauea volcano on the island of Hawaii. The openings are cased around the top and capped so that temperature tests may be taken at any time. It is thought that a rise in the mercury would presage an eruption and thus a "log" of the life of the volcano would be afforded. The holes are 1,000 feet apart and were dug with compressed-air drills.

VEST-POCKET SIZE HAND PUNCH IS USEFUL IN HOME

For the mechanic and home worker, a small punch now on the market is said to penetrate readily sheet material up to about three-thirty-seconds of an inch in thickness with a minimum of effort. The punch itself is contained in the end of a threaded screw which has a small lever handle for power. The die into which the metal is forced, is in the base of the frame. A gauge prevents forcing in sheets too thick to be penetrated, and the entire punch is so small that it may be carried conveniently in the vest pocket.



UMBRELLA TO MATCH RAINCOAT CONTAINS RUBBER FABRIC

In the wake of the brilliant-hued raincoat has come the umbrella to match, a rubberized article that is said to weigh no more than the ordinary kind and has a soft, velvety finish, without the glaze sometimes considered an objection in material of this kind. The frame is strongly constructed with ten ribs, and the umbrella is furnished in a wide variety of shades ranging from blue, green, red and other plain colors to plaid.

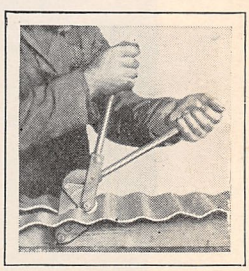
Illustrating the Way Rake Is Used, and Close View of Teeth Reaching between Shrubbery

LAWN RAKE WITH LONG TEETH USED LIKE BROOM

Equipped with long, steel tines that reach in between the shrubbery and do not tear up the sod, a special rake for lawns is wielded with an easy sweeping motion, does not become clogged readily and stirs the soil without injury. The tines are fitted securely into a steel yoke.

CORRUGATED-METAL SHEARS CUT WITHOUT DISTORTION

In cutting sheets of corrugated metal, the edges are usually bent out of shape and have to be straightened. This is said to be unnecessary with a lightweight pair of shears, nearly small enough to be slipped into the pocket, which cut straight, on curves or obliquely across the sheet without distorting the corrugations. It has two rotary, double-edged cutters, knurled on the shearing edges, and is held to the metal by means of a screw cap, which may be quickly loosened when the operator desires to withdraw the shears.



Our RADIO WORLD

Dr. Lee De Forest Forecasts Future Developments in Wireless

By J. OLIN HOWE

WHAT is on the radio horizon? And beyond it? What lies over the hill?

"Radio will be as much a commonplace with the next generation as the telephone with this, lifting civilization to new levels," answers Dr. Lee De Forest, inventor of the "talking lamp," the radio tube known as the audion.

Although more than 3,000,000 radio sets were placed in American homes last year, the tube is only twenty years old. Without it we should be unable to telephone across the continent, and multiplex telegraphy and telephony both—by either of which numerous messages may go over the same wire circuit at the same time—would be only a dream.

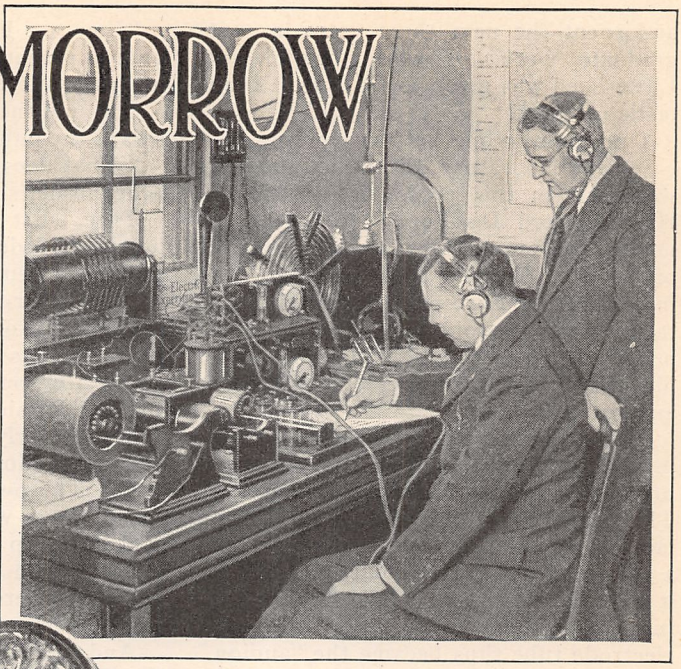
The tube makes possible the sending of pictures and writing by wire or by wireless, it gives us the talking movie, it has revolutionized the art of recording and reproducing sound by the phonograph, and it will give us television, and much besides.

Yet the real birth of radio as we know it today occurred twenty-six years ago when De Forest, sitting in his $2-a-week hall bedroom in Chicago on a warm September evening, first observed the "Welsbach effect" which led to the invention of the talking lamp later on.

"I went crazy mad over that," Dr. De Forest said recently, "because the fluttering of the flame in the Welsbach burner gave me the idea that heated gas around an incandescent mantle might be sensitive to wireless waves. Later I substituted the filament in the electric lamp."

De Forest was hardly more than a year beyond his graduation from Yale at the time, but had been out in the workaday world long enough to find that his degree got him very little there. An electrical company was willing to pay him $8 a week and he eked out this income by translating French articles for a technical publication and by teaching nights. It was the same company that later paid him

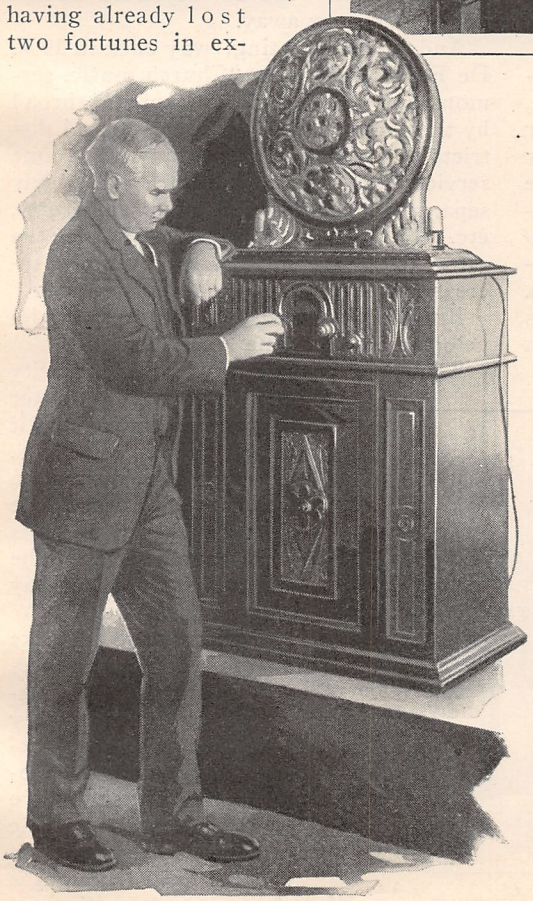
# of TOMORROW



Old-Time Receiver and Dr. De Forest at a Modern Set; Swift Radio Changes of Recent Years

something like 50,000 times the amount of this his weekly salary for the right to use his tube in the telephone business. Not at once, however, did De Forest perfect his invention and certainly not for many a year did recognition come to him. Men of science and captains of industry scoffed at the "useless toy."

As recently as the summer of 1912, De Forest, having already lost two fortunes in experimental work, was employed as a research engineer of a California company at a small salary. He needed $125 to save his French patents and went to the president of the company he worked for to borrow this sum. In return, De Forest offered a half interest in his French rights. The president thought it too much of a gamble and, to the despair of the inventor, his French patents reverted to the government. Two years later came the war and the magic tube took its place as the very heart of military communication. Countless bulbs were supplied the allied armies.



De Forest sighs in recalling this. "One million dollars is a conservative estimate of the royalties which would have been paid during the war years, if I had been able to hold on to those French patents," he says. "Unfortunately my friends believed I was only dreaming."

An eminent professor of electrical engineering had thought even less of the ideas of the student, De Forest, years before. The latter graduated from Sheffield scientific school in '96

and spent the next three years in post-graduate work for a doctor's degree. Little heed was given to De Forest's fantastic research.

One night, while he was working in a basement laboratory, the lights suddenly went out in this professor's classroom. He suspected De Forest of having removed the wrong fuse, but could never prove it. Shortly after, however, he found that De Forest had nailed his apparatus to a laboratory table. This was too much. "A student who will spoil a table like that," said the professor, "will never amount to anything."

Much time elapsed between the observing of the Welsbach effect and the actual production of the vacuum tube in 1906. This tube, about the size of an Edison lamp, contained a filament, a grid and a plate and De Forest coined a name for it from "audio," to hear, and "ion," meaning one or more electrons. The three-electrode tube thus became the "audion."

In 1912, the telephone company, seeking to extend its long-distance service, purchased the audion patent rights for $140,000. In less than two years, they were able to open service across the American continent. Later the same company paid $250,000 more, for the little lamp had grown from a mere child of imagination to a full-sized servant of mankind. It relayed wireless dots and dashes across the sea and it carried the human voice on telephone wires over the land.

"Now we have all there is under the audion patents," said a leading telephone attorney to a friend of De Forest.

"But not the exclusive right to sell radio sets to the public. De Forest retains that."

"What does that amount to?" cried the other in derision.

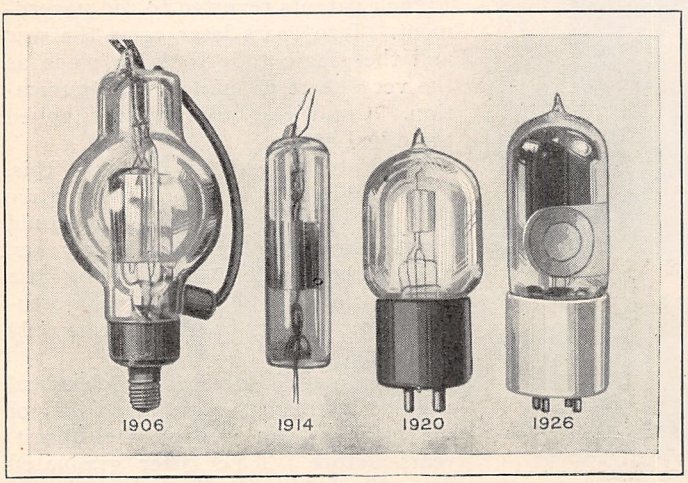
True, what did it amount to nine years ago? Broadcasting, actually first done publicly when, on July 15, 1907, the races of the Inter-Lake Yacht association at Put-In-Bay on Lake Erie were reported by radio, was a joke in 1917. Even three years later, on Nov. 2, 1920, when KDKA of East Pittsburgh went on the air as the first regularly established broadcasting station, radio was still something of a joke. The owners of the station had decided there was a future in radio, and had made up fifty sets, and induced fifty wealthy men to spend $100 each, though the purchasers believed they were throwing their money away.

And of broadcasting, 'way back in 1907, De Forest had said: "Church music, sermons and lectures can be spread abroad by the radio telephone. In the rural districts scores of individual radio-telephone services can be maintained between widely separated farms, ranches, crossroad stores, etc. For the distribution of music, the radio telephone means an enormous increase of patronage among music lovers."

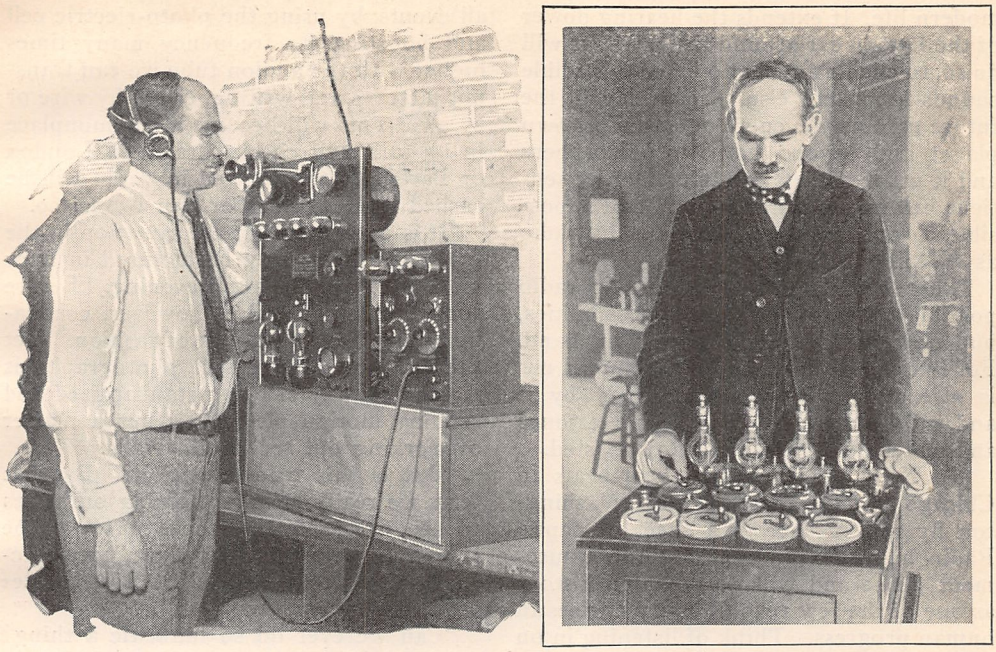
But De Forest visions still greater developments in the next few years.

"Amazing improvement in the quality of reception is a matter of the near future, and it must come," he says. "Instead of many tubes, we may substitute one big tube which will do its work much better. The photo-electric cell may give us television.

"Broadcasting will take on entirely new phases and conceivably the national government may take over all broadcasting of a general or public nature. We shall have radio schools—a whole system of education in which all instruction is given over the radio, and



Another Illustration of Radio's Rapid Development; Changes in Tubes, the "Talking and Listening Lamps," since 1906



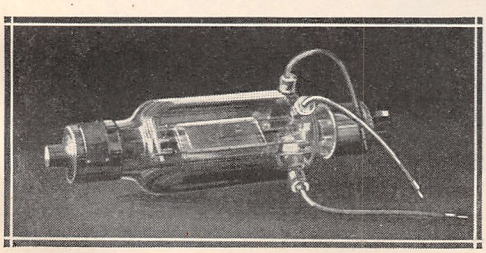
Two Pioneer Sets of Apparatus, Yet Each Is But a Few Years Old; at the Left, Dr. De Forest at His Wireless Telephone of 1919 and, at Right, an Audion Hook-Up of Yesterday

we shall have radio newspapers and magazines, and perhaps a radio church.

"Radio telephony and wire telephony will be linked up to a degree which will make it possible for us to listen to broadcasting over our telephone wire, and doubtless plug in a loud speaker on a telephone circuit.

"While it has already made itself indispensable in our daily lives, it is a fact that radio is yet in its merest infancy. The task directly ahead is to improve the speaking and singing voice of radio.

"There is no set today which, with its loud speaker, gives perfect reproduction of music. Every set, and many loud speakers, distort the sound in some way. Designers have been too economical, have sought to make one tube do the work of two, have tolerated back-feeding—have failed sufficiently to shield the various elements. We must remember this, though, that in radio the extreme sensitiveness essential to true reproduction calls imperatively for good broadcast reception. The loud speaker cannot make up for deficiencies in the receiving set. Here we come to the limitations on the number of tubes which can be used to advantage, and we run into difficulties in the multiplication of tubes which seem likely to be overcome by the use of one large audion equivalent to several smaller ones, with diverse steps of radio-frequency amplification in the same tube.



Early Vacuum Tube Dr. De Forest Developed for Sending Messages; He Called It the Oscillion

"Now something about static? Unfortunately man doesn't subdue the forces of nature which he learns to utilize. At least, not in his present stage of development. He doesn't even adapt them; he adapts himself to them.

"Can we conquer static? Probably not, put as baldly as that. At least, not for a very long time. But we can learn its diagnosis, as we have that of lightning, and how to insulate ourselves from it and, somewhat, to keep out of its way.

"To me the delightful thing about radio is that it enters so indispensably into

modern life. It extends the hearing power of the human ear around the earth, or will do so, to enable anyone to listen to audible sounds anywhere else. Some day in the future man may even go out from his own planet and beyond his own atmosphere and if other planets are inhabited by sentient beings, he and they may find it possible to communicate. But not by radio as we know it today.

"There are far more interesting radio possibilities—and not only possibilities, but certainties — much nearer at hand. For one thing, the range of the human ear is already increased astonishingly by it and will be more so. We hear overtones and undertones we didn't know existed.

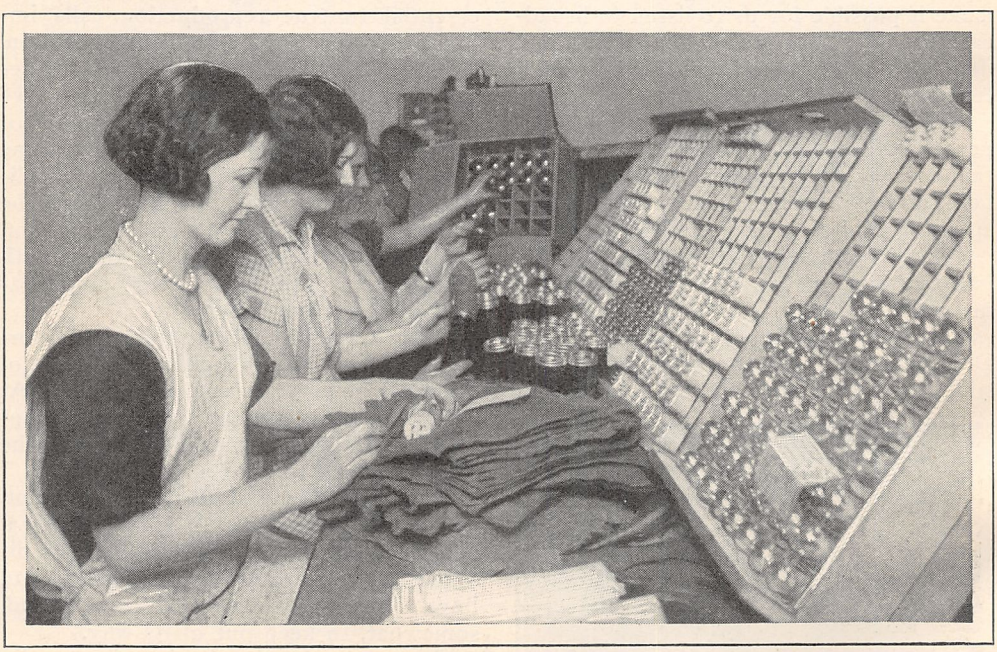
"In New York we hear heartbeats in Chicago and the footsteps of a Washington fly walking across a sheet of paper. Radio has long since passed the amusement phase and will go down in history as one of the few revolutionary devices in human progress. Think of listening in on a tiger hunt in India, or an elephant hunt in Africa—on war and all that goes with it—on parliamentary debates and world events of any important kind. All this will come.

"Television we have now, in a way. At all events, by using the photo-electric cell and boosting its frequency many times higher with the audion tube we can transmit pictures and writing, either by wire or by air. This will become a commonplace in its turn and checks drawn in London or Paris and transmitted by radio will be cashed in New York or San Francisco.

"It is even said that a coronation in the first-named city may be pictured in New York theaters the same evening. Before such a feat is possible, however, coronations may have gone out of fashion. Yet the transmission of still photographs is already by way of being standardized and sending motion pictures is but a matter of working out technical details.

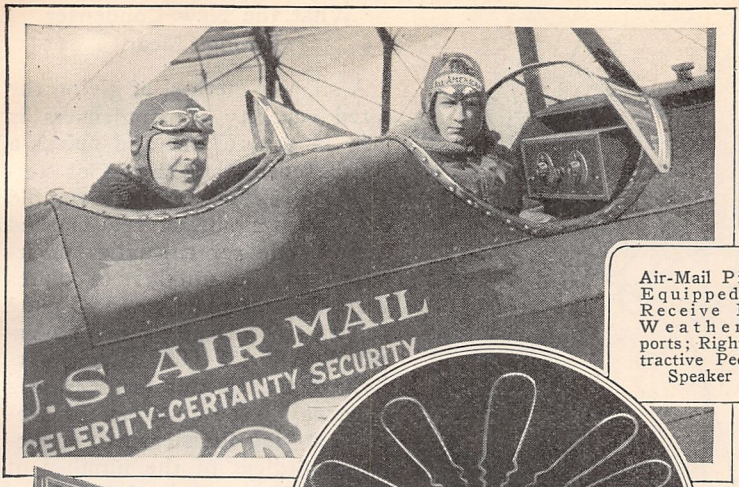
"But is this true television? By that term we really mean the ability ourselves to see over long distances. Not to be shown pictures taken far away, but to actually view the scene itself in Los Angeles while we are in New York.

"Can we ever do so fantastic a thing? Theoretically, it is possible. Commercially and financially, it is impractical. Even so, I can say that there are undreamed of possibilities in radio—possibilities perhaps limitless from any standpoint of human limitations!"

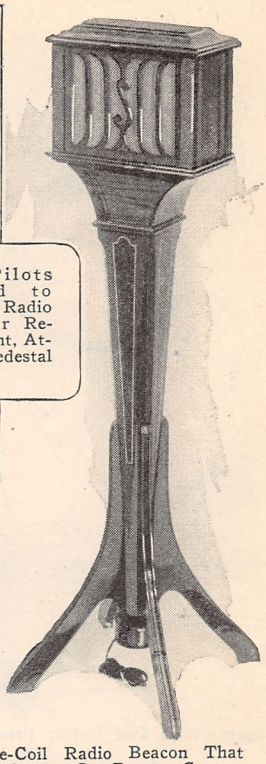


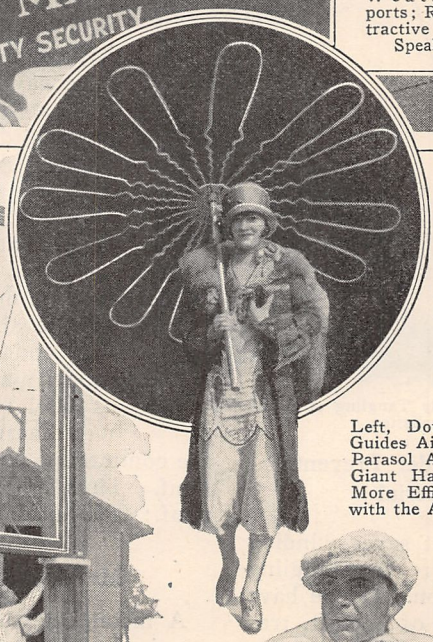
Wrapping and Packing Radio Tubes for Shipment; These Magic Little Units Are Handled Carefully as Befits Parts That Have Played So Important a Role in Radio's Progress

Here Are Radio's Latest Novelties

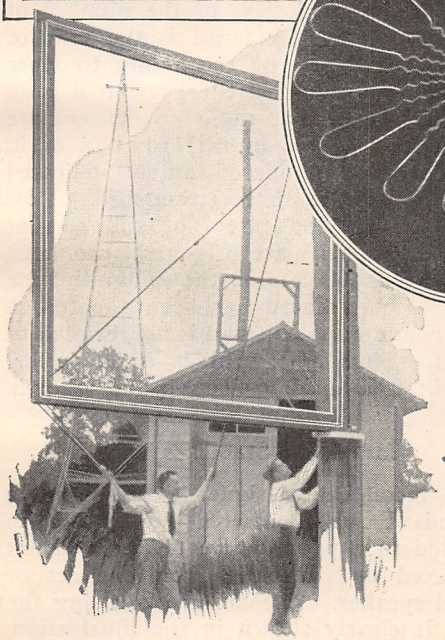


Air-Mail Pilots Equipped to Receive Radio Weather Reports; Right, Attractive Pedestal Speaker

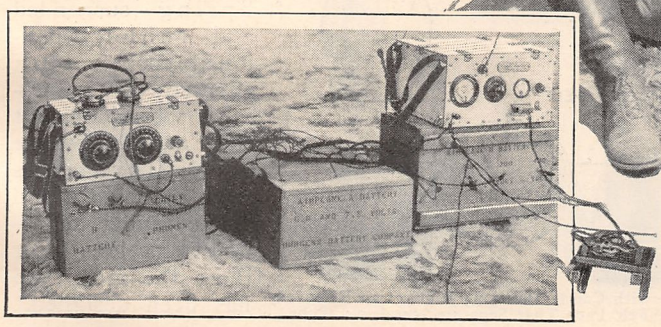




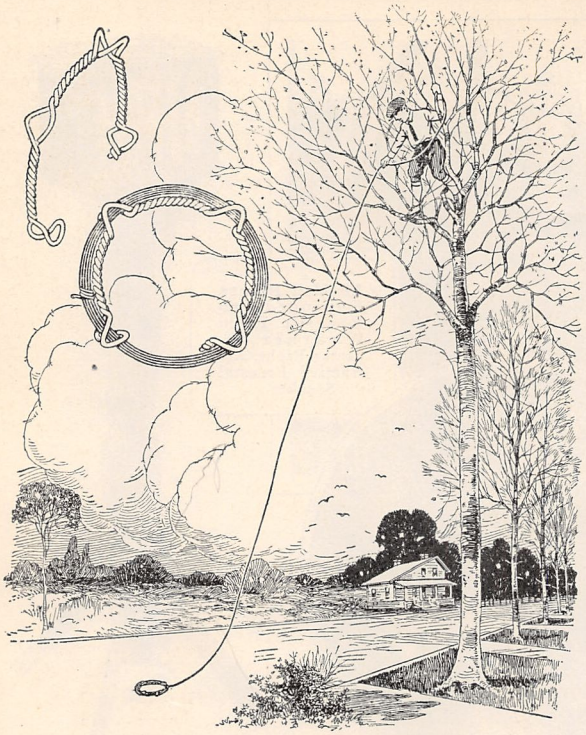
Left, Double-Coil Radio Beacon That Guides Aircraft over Its Route; Center, Parasol Aerial Looks like a Rosette of Giant Hairpins; It Is Claimed to Be More Efficient Than the Usual Aerial, with the Added Advantage of Portability



Below, Arctic Radio Equipment with Battery Supply Designed for the Detroit Arctic Expedition; It Represents the Latest Type of Low-Power Low-Wave Apparatus



Above, James Cruze, Directing Naval Battle Scene for Big Picture by Radio; This Method of Supervision Enables the Director to Keep in Constant Touch with All the Various Units of Elaborate Productions Employing Hundreds of People Spread over a Large Area



Spring-Wire Coil Holder Prevents Tangling of Aerial Wire during Installation

Spring-Wire Coil Holder Prevents Tangling of Aerial

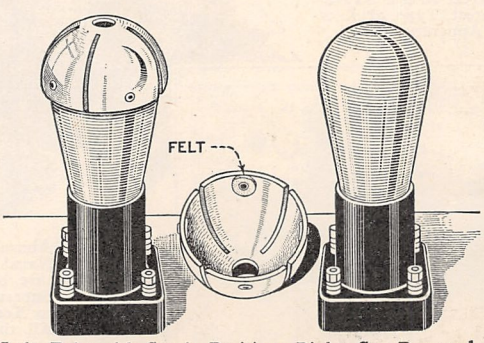
A wire coil holder that saves winding the wire on a spool and prevents tangling is shown in the illustration. If you have ever climbed to the top of a 60-ft. tree with a tangle of aerial wire hung to every limb and the wind blowing a gale, you will appreciate the usefulness of such a coil holder. The device is simple and easy to make, the construction being indicated in the diagram. It consists of a length of steel wire twisted, as shown, with the idea of making a holder of variable size, so that it will fit coils of different diameters. The wire used should be springy, and as it does not form a complete circle, it will adapt itself to the coil and hold it firmly.—Watson Brown, Iuka, Miss.

What the New Condenser Ratings Mean

A simpler method of giving the rated capacity of condensers is now in general use and marks a third step in the interest of simplicity and efficiency since the old days when manufacturers marked their condenser capacities in relation to the number of plates used. Several years ago a 23-plate variable condenser was understood to be of .0005-mfd. capacity, etc.; then this crude rating gave way to the more exact method of stating the measured capacity regardless of the number of plates. A farad is the unit of capacity, or the ability to store up electrical energy; but it is so large that radio condensers are measured in millionths of it, called a microfarad and indicated by the abbreviation mfd. Now that condensers of still smaller capacity are in general use, such as .0001 mfd., the millionth of a microfarad has been adopted as the commercial unit and is abbreviated to mmf. Thus .0001 mfd. is equal to 100 mmf.; .00004 mfd. to 40 mmf., and so forth.

Metal Cap Stabilizes Tube

A metal cap, designed to fit over the standard tube, changes the oscillation period to a point where the tube is not affected by vibrations from the set or loud speaker. The method of using the cap is clearly shown in the illustration, and is quite different from the usual devices for eliminating tube vibration. Spring-suspended and rubber-cushioned sockets often eliminate or minimize vibrations, but there are cases where heavy vibrations from machinery and traffic render all efforts useless. For these the metal cap has been designed.



Left, Tube with Cap in Position; Right, Cap Removed, Showing Felt Pads That Separate Metal and Tube

Cheap Homemade Battery Charger

By JOSEPH PAULY

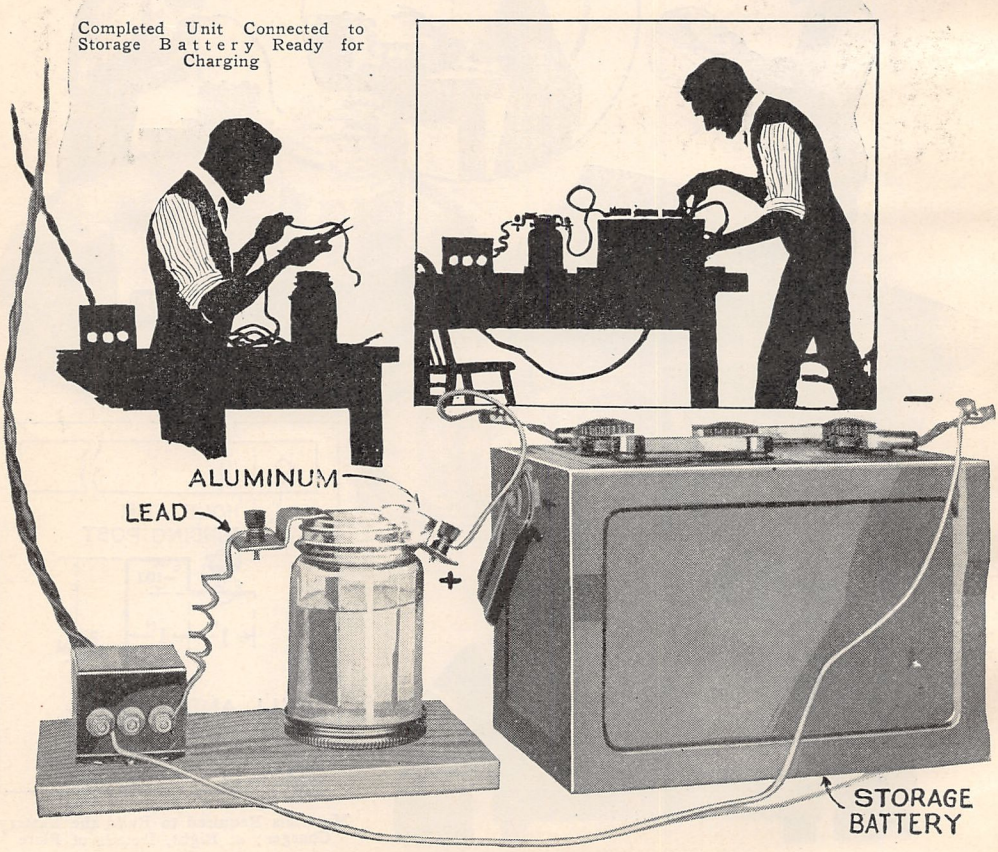
THIS simple battery charger or "booster," made from odds and ends about the average home, costs but $2.50, is extremely simple to build, and saves many trips to the battery station. It is not intended for large sets that place a heavy drain on the A-battery, as the charging rate is low, but is especially adapted for sets with not more than 5 tubes of the A-type on a 6-volt battery or those employing 199 or similar tubes on a 4-volt storage battery. It is used in the same manner as the well-known trickle chargers now on the market, and can be left connected for long periods without overheating or even getting warm. After having the battery fully charged, the author connected the little charger, placing the battery on charge when the set was not in use. The materials required are a small glass jar of the type used for preserving, a bell-ringing transformer of the tapped type, an aluminum pie plate, a strip of lead, two binding posts, a ¼-lb. box of borax and a board, ½ by 6 by 10-in., for the base. The bell-ringing transformer is of the common step-down type tapped for various voltages, usually 6, 12 and 18 volts, and may be obtained from any dealer in electrical supplies. The aluminum and lead plates are 1½ by 7 in. and are bent in the manner shown in the diagram so as to fit over the top of the jar. The former is cut from the pie plate with a pair of tin snips, and the lead plate from a 1/16-in. sheet which can be obtained at a plumbing shop. Holes

Materials Required to Build the Battery Charger; at Right, Details of Plate

for the binding posts are drilled in the end of each strip. The step-down transformer is screwed to one end of the baseboard and the glass jar is placed at the other, as shown. The jar is held in position by the top of a tin can, to prevent it from shifting about. Dissolve ¼ lb. of borax in about 1 pt. of distilled water and let it set. It will be found that a portion of the borax will not dissolve but will remain at the bottom. The clear solution should be poured off, being careful not to disturb the sediment. The sediment is then washed out of the container and the clear solution poured into it until the jar is three-fourths full. Now hang the plates in the jar, in the position shown, and connect the rectifier jar across the transformer to form the cell, using either 12 or 14 volts. The transformer is then plugged into the 110-volt line, the cell-forming process taking about 12 hours.

This forming process is necessary since, up to this point, it will not rectify alternating current; the process converts the cell, which would previously pass current in either direction, into one that will pass current in one direction only. As the cell forms, the aluminum plate will turn light gray where it is exposed to the action of the solution. This coating is an aluminum oxide, insulating the lead from the aluminum plate, when current attempts to pass from the aluminum to the lead plate, but acting as a conductor when the current passes in the reverse direction.

If, after five or six hours of forming, the aluminum plate has not turned to a light gray, but has a dark-slate appearance, the cell has refused to form. There may be one or more reasons for this; first in importance, that the water used for the solution is not properly distilled, second, that the aluminum is not pure, and third, that the plates are not clean. Remove the plates, dry and rub them down with emery cloth to remove any grease or foreign matter; make sure the aluminum, and dis-



Completed Unit Connected to Storage Battery Ready for Charging

tilled water used are pure. After the plate is formed, the charger is connected to the storage battery, as shown in the photo. The aluminum plate is always positive and goes to the positive of the storage battery; the negative terminal of the storage battery is taken to the transformer, the other side of the transformer being connected to the lead plate. A little oil on top of the solution will prevent creeping and evaporation, but the cell requires no further attention. The charger can be left connected to the battery for long periods without heating, and draw practically nothing from the lighting circuit; the charger is for 100-volt, 60-cycle alternating current only, so it is well to see what type of current is available before building the unit. Besides the material already mentioned the only supplies needed are two binding posts, and 5 ft. of ordinary lampcord, with plug.

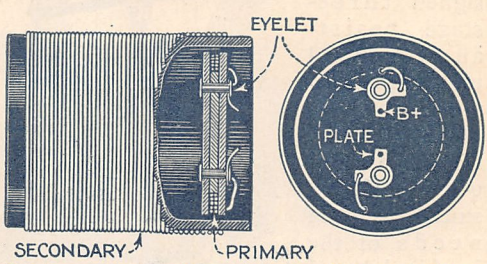
How Cell Is Connected across the Transformer for the Cell-Forming Process

Re-Marking Radio Dials

Radio dials and lettered binding posts often become darkened and worn, due to constant handling, but they can be made like new with little effort and expense. Obtain a small tube of Chinese white at a painters' supply store. Remove the old white filler from the dial or binding post with a sharp tool, a large darning needle being ideal for this purpose. It is important that the engraving be cleaned out thoroughly before refilling, or the new paint will not stick. Put in the new filler of Chinese white and allow it to set for three minutes. Now hold a piece of cloth flat on a table and rub the post or dial on the cloth to remove the excess filler.—John C. Heberger, Rochester, N. Y.

Efficient Primary for R. F. Transformers

The idea of winding the primary of a r.f. transformer in a slot or groove is not a new one, but it has the advantage of reducing the capacity coupling between the primary and the secondary. The sketch illustrates an easily made winding form for such a primary. Three round disks of 1/16-in. bakelite are held together with two ordinary shoe eyelets. Two of the disks are of the same size, the third and smaller one being placed between the other two. The three are clamped together and drilled for the eyelets, and the latter inserted and clinched over the terminals. The primary, consisting of 15 to 20 turns of No. 32 d.s.c. wire, is wound in the slot; the ends are soldered to the terminals, and the finished coil slipped inside the secondary, whereupon the terminals are connected to the B+ and plate as indicated. The eyelets which are used to hold the plates together should be obtainable at any shoe store. If 1/16-in. bakelite is not available, cardboard will serve the purpose practically as well.—Hugh G. Bersie, Chicago, Ill.



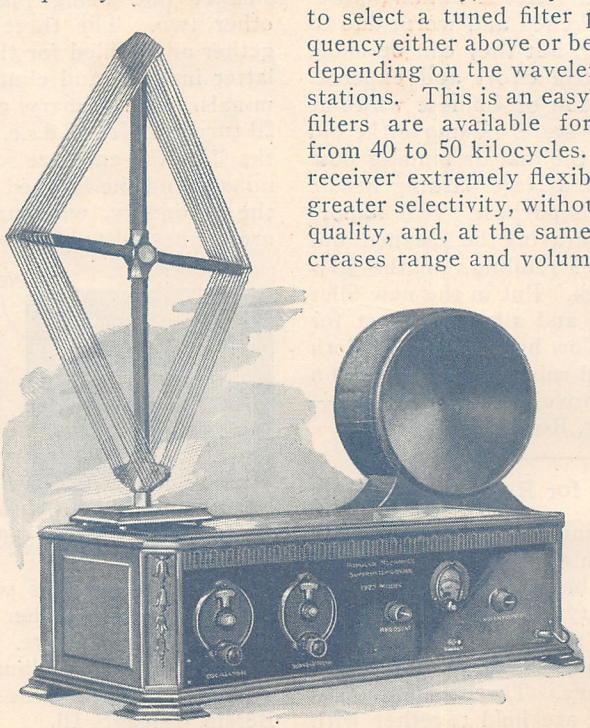
Cut-Away Section Shows Primary Coil in Position; Right, End View with Primary Terminals

EXCEPTIONAL SIMPLICITY is Feature of LATEST SUPERHET

by Frank L. Brittin

AS easy to build as the average 5-tube set, this latest product of Popular Mechanics radio laboratory introduces an entirely new note in modern superheterodyne design. The superiority of this well-known circuit is undisputed; when correctly built, it has invariably proved its right to the title "Rolls-Royce" of radio receivers. Up to the present time, however, it has been necessary for the average superheterodyne builder to follow several hard and fast rules to obtain the remarkable selectivity, tone and range for which the circuit is noted. Without facilities for carefully matching tubes, checking i.f. transformers and proper shielding, no two sets worked exactly alike; some were good and others no better than the average tuned r.f. sets, depending on the skill of the builder and the quality of the materials available.

All hit-and-miss methods are eliminated in this powerful and selective receiver, which employs a specially designed three-stage resistance-coupled unit, making possible the use of any intermediate-frequency best suited for the needs of the individual builder. In the early days of superheterodyne development, resistance-coupled i.f. amplification was used with excellent results. This method, however, was used by only a few experts, who, after many experiments, occasionally found just how much drawing ink and graphite from lead-pencil shavings would turn the trick. Today we have highly developed permanent resistor units available for all, and it is no longer necessary to depend on specially peaked and matched transformers nor upon arbitrary frequencies that must be carefully filtered out to obtain maximum results.



For the model described, which, of course, is used in the Chicago territory, a tuned filter peaking at 46 kilocycles was used, as this was found to keep at a minimum the interference due to harmonics from powerful stations in this region. While this frequency may be used in any other territory, it may be found advisable to select a tuned filter peaking at a frequency either above or below 46 kilocycles, depending on the wavelengths of the local stations. This is an easy matter, since the filters are available for any frequency, from 40 to 50 kilocycles. This makes the receiver extremely flexible, and results in greater selectivity, without sacrificing tone quality, and, at the same time, greatly increases range and volume. Perfect interstage amplification, due to the resistance-coupled unit and the use of extra-heavy a.f. transformers, capable of handling both the higher and lower frequencies, makes possible the true reproduction of the living voice. With a suitable

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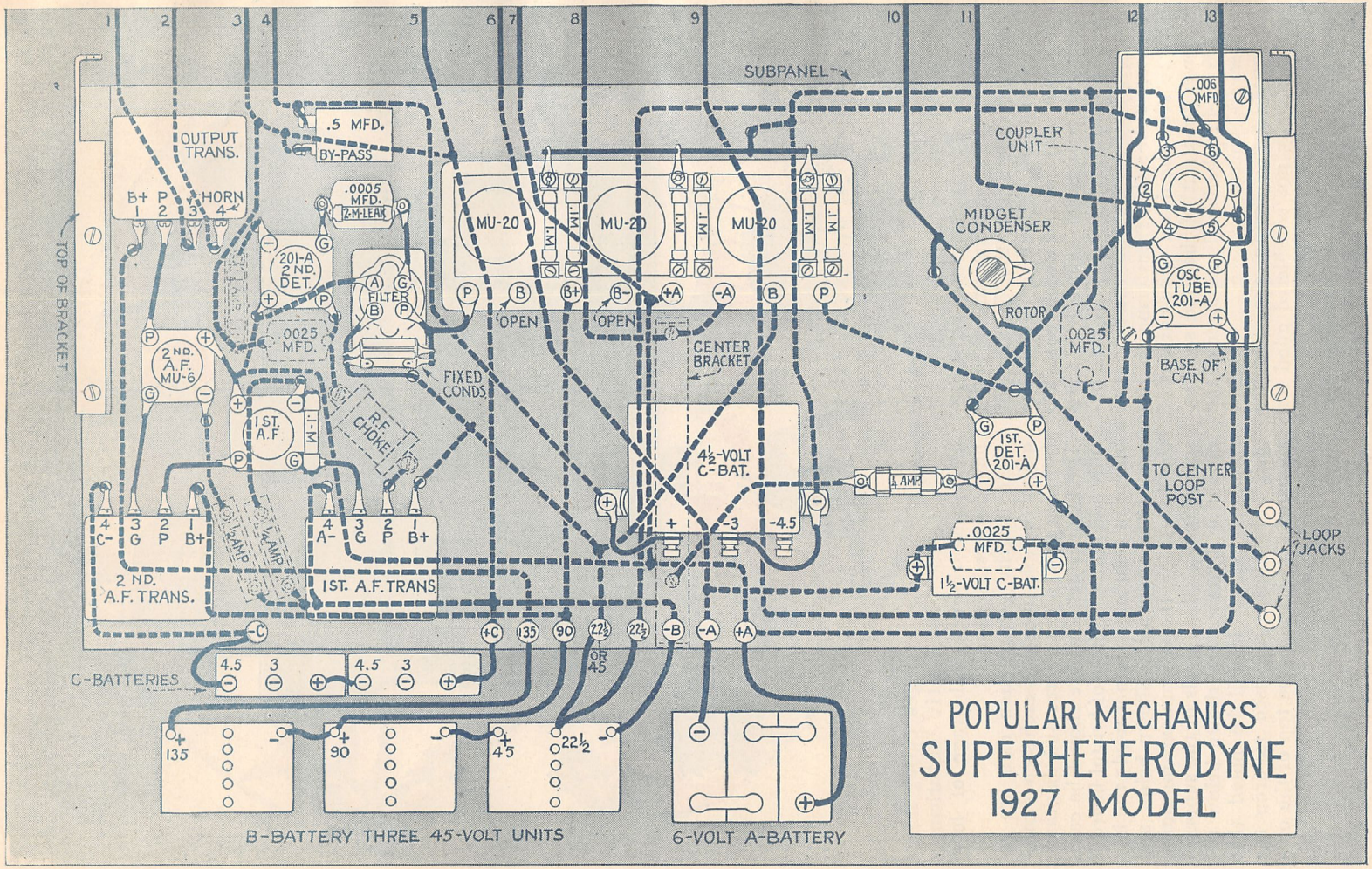
speaker or combination of horn and cone speaker in series, capable of truly reproducing the output of the receiver, each instrument in the orchestra can be heard; the low notes of the bass and kettledrums as well as the high-pitched clarinet and piccolo notes are given their true tonal values. A third transformer of the output type is used between the loud speaker and the output of the power tube; this transformer is designed to keep the direct plate-current of the power tube out of the loud speaker, thus increasing the handling power of the latter several times.

Distance tests during the summer months, usually not considered good for radio reception, resulted in a log of some sixty stations scattered over the east coast, Canada, and southern states. Most of these stations were logged during severe static disturbances and many through a barrage of local high-powered stations.

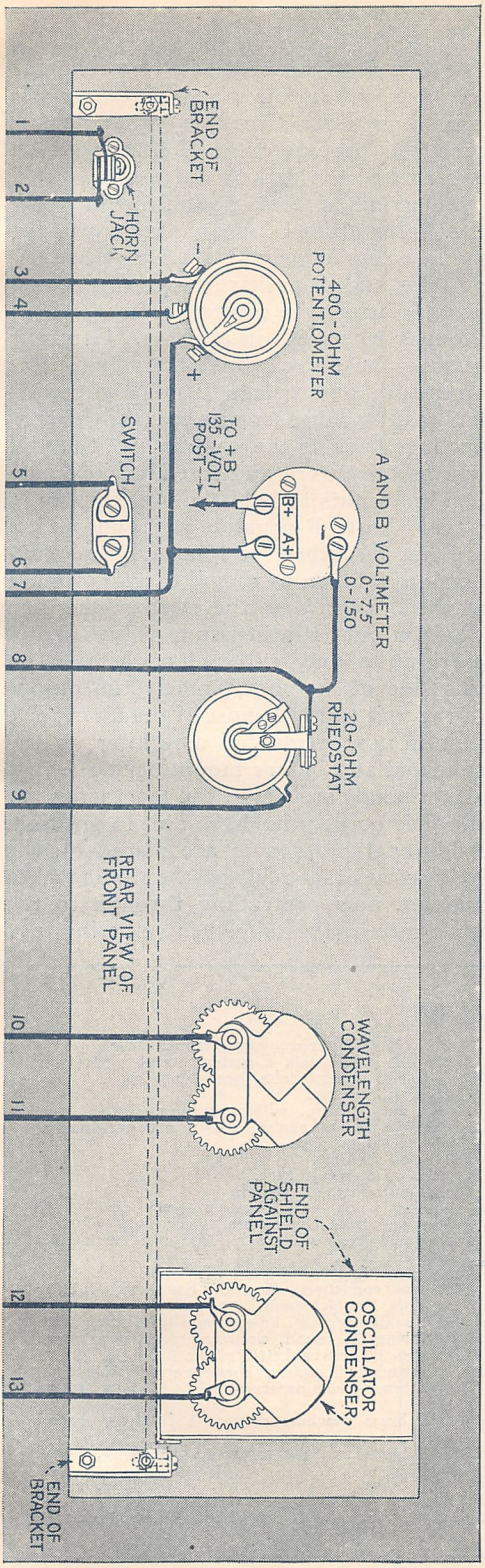
No lengthy construction data are required to build this set as each step is carefully covered in the photos and diagrams. The front-panel template should be carefully laid out on a sheet of bristol board if blueprint templates are not used; the layout of the subpanel is shown below and the holes for the instrument mounting screws indicated. Details of the subpanel mounting brackets are shown below the subpanel layout; it will be noted that strips of bakelite are used to drop the subpanel 3/16 in. below the top of the outside brackets to make room for the aluminum "can" or shield above the subpanel.

The oscillator unit is completely isolated



POPULAR MECHANICS SUPERHETERODYNE 1927 MODEL

660



in this aluminum can, shown in the photo at the right. This can may be obtained with most of the holes drilled and ready for use; the top and bottom are removable, the base of the can is screwed to the subpanel and the tube socket and universal socket for the plug-in coupler unit mounted in the position shown. Three short lengths of brass tubing furnished with the unit are used to elevate the coupler socket about ½ in. above the base of the can. The tube socket is mounted directly on the can base or can be slightly raised on bakelite strips if desired. The .006-mfd. fixed condenser is mounted on the base of the can directly in front of the coupler unit under the oscillator condenser, one side screwed to the can for the A-negative connection and spaced by an extra brass nut, as shown in the detailed diagram. The other side of this fixed condenser does not touch the can and is provided with a soldering lug and connected to the No. 6 post on the coupler-unit socket. Holes are drilled in the can base and subpanel near each terminal of the tube socket and coupler-unit socket, all leads to these terminals being taken below the subpanel and insulated from the can with short lengths of good black spaghetti tubing.

Next assemble all instruments on the front panel except the oscillator condenser and screw the front panel temporarily in place on the outside subpanel brackets. When assembled, the front edge of the can base should be against the front panel. Place the sides of the can in position in the base and line up the condenser mounting holes on the front of the can. After drilling the holes in the can, enlarge the hole for the condenser shaft so no metal will come in contact with the shaft when the condenser is in position. When completely assembled and the lid in position, this aluminum can effectually shields this usually "touchy" part of the circuit. The oscillator condenser, top and sides of the can are then left off the assembly until all the wiring is completed, the last two wires from the oscillator condenser to the coupler terminals 4 and 5 being added after the can is finally assembled. The subpanel layout shows each instrument above the subpanel in its proper position; the only instruments below the subpanel being the r.f. choke coil, by-pass condensers and filament control ballasts shown in the large wiring diagram and indicated by

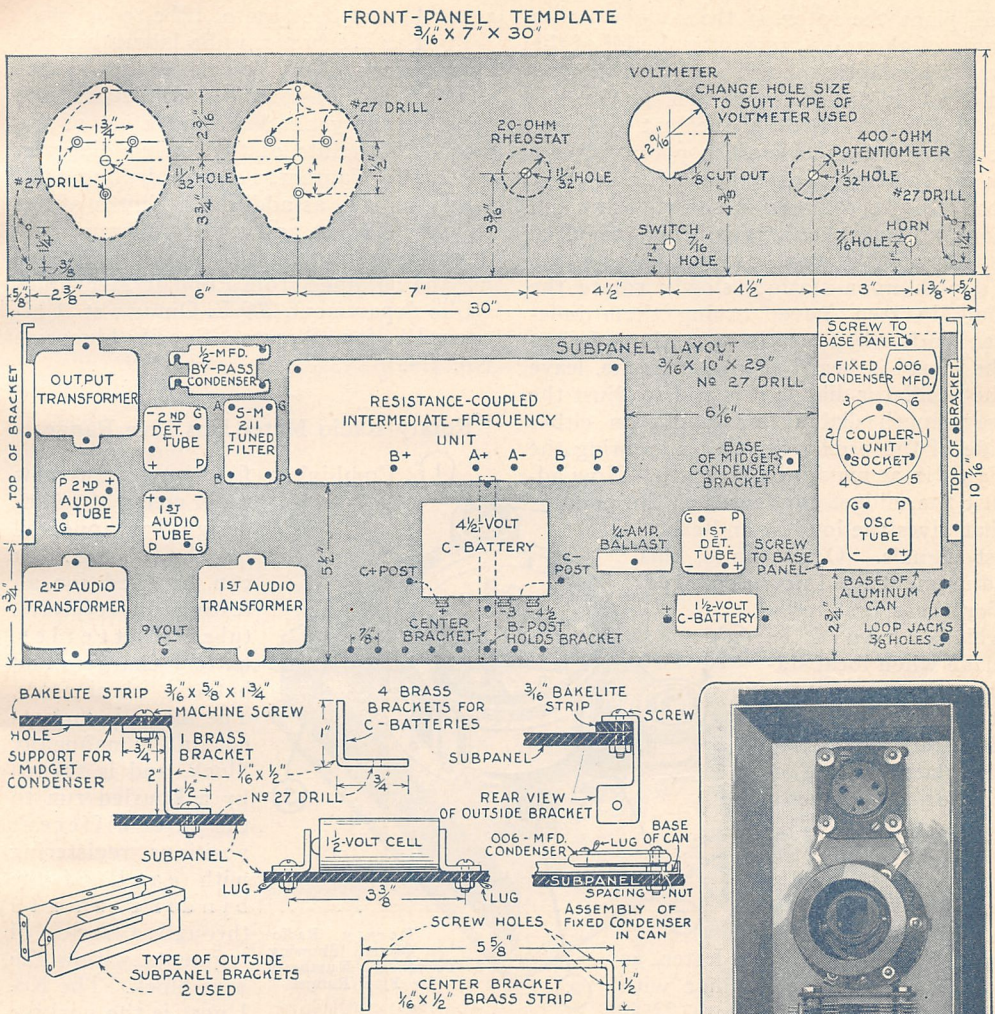
dotted lines. The ballasts are all below except the one for the first detector tube; a single brass machine screw holds each ballast mounting in position on the subpanel, and the choke coil is held in position with a short brass machine screw at each end, as indicated. These ballasts are ¼ amp. each, except the one for the power tube MU-6 in the last a.f. tube socket; this ballast must be of the ½-amp. type. The MU-6 tube used has a 6-volt filament, and, while the ballast indicated is not necessary for this tube, it is installed so that other types of tubes may be substituted, if desired, in the second a.f. stage. Three MU-20 tubes must be used in the resistance-coupled unit; therefore the 6-volt filament supply line is taken directly to this unit.

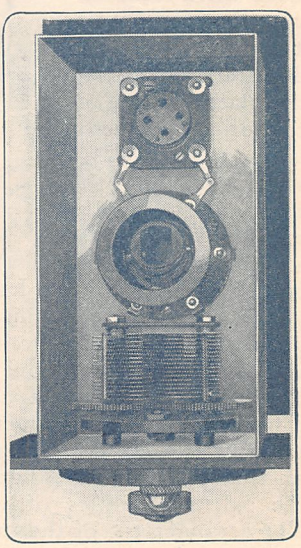
There are a few slight changes necessary in the resistance-coupled unit to facilitate wiring under the subpanel, and these changes must be made before this unit is mounted in its position. Six small C-battery posts will be noted on the upper front edge of the unit; these posts are connected together on the underside of the unit with short metal strips. Remove these strips and replace the nuts as you found them; soldering lugs are then placed under the three binding posts located on the top of the unit at the end of each resistor marked 1.M and connected together with a short length of busbar wire as shown in the wiring diagram. The remaining three C-battery posts nearest each tube have no external connection on this side of the unit.

Referring to the subpanel layout, note the holes drilled in the subpanel and marked respectively P, B, A-negative, A-positive and B-positive; these holes are directly below the corresponding posts of the unit when it is in position. Carefully remove the corresponding binding posts on the unit and replace them with five 1½-in. brass machine screws; leaving the connecting strips on the underside of the unit just as they were and screwing up hexagon brass nuts to hold the strips firmly in place. Posts B-negative and "output" B are not disturbed, and no external connection is taken to them; these posts are marked "open" in the wiring diagram. The "output" P-post is not disturbed and carries the only external connection on this side of the unit, namely the output of the unit to the P-post of the filter. The unit is now ready for mounting on the subpanel and before mounting it see that all terminals are tight; the long screws at the four corners hold the unit in position. Additional brass nuts are placed on the long screws that replaced the binding posts and are now protruding through to the underside of the subpanel; soldering lugs

MATERIAL LIST

1 front panel, 3-16 by 7 by 30 in.
1 subpanel, 3-16 by 10 by 29 in.
2 strips bakelite, 3-16 by ½ by 5 in.
1 strip bakelite, 3-16 by ½ by 2 in.
1 Daven 3-stage super-amplifier unit, type 3-R.
3 Daven ¼-amp. ballasts, complete with No. 50 mountings.
1 Daven ½-amp. ballast, with No. 50 mounting.
3 Daven MU-20 tubes.
1 Daven MU-6 power tube.
4 201-A tubes.
1 S-M plug-in-coupler unit, type 110-A.
1 S-M universal socket, type 515.
1 S-M tuned air-core filter, type 211 (available for any frequency between 40 and 50 kilocycles) any of which may be used.
2 S-M a.f. transformers, type 220.
1 S-M output transformer, type 221.
1 S-M aluminum shield, type 631, for oscillator unit.
2 Remler capacity units, .0005 mfd., type 631.
1 Jewell or Hoyt A and B voltmeter, double range, 0-7.5 and 0-150 volts.
5 standard spring-suspended sockets, Benjamin or similar type.
3 cord-tip plugs and jacks.
2 Benjamin subpanel brackets.
1 Samson r.f. choke coil.
2 National velvet-vernier dials, type B, dual range.
1 midget condenser, Chelton or S-M, low-loss type.
1 three-tap, loop aerial, box type preferred.
3 4½-volt C-batteries, large, tapped type.
1 1½-volt single cell, C-battery, large type.
3 45-volt B-battery units, heavy-duty type.
1 gridleak, 2 meg.
1 gridleak, .1 meg., with mounting clips.
1 400-ohm potentiometer, Frost, Yaxley, Centralab, or similar type.
1 20-ohm rheostat.
1 jack, open-circuit type.
1 push-pull filament switch.
11 binding posts, with engraved tops.
3 Sangamo fixed condensers, .0025 mfd.
1 Sangamo fixed condenser, .0005 mfd., with gridleak clips.
1 Sangamo fixed condenser, .006 mfd.
1 by-pass condenser, ½ mfd., Sangamo, Dubilier or Tobe-Deutschmann.
8 doz. soldering lugs, long, round-hole type.
10 2-ft. lengths, round, tinned-copper busbar wire.
4 lengths black spaghetti tubing.
2 ft. stranded, flexible, rubber-covered fixture wire.
12 6-32 brass machine screws, 1½ in. long, round head.
18 6-32 brass machine screws, 1 in. long, round head.
30 6-32 brass machine screws, ½ in. long, round head.
7 6-32 brass machine screws, ½ in. long, round head, nickelplated.
20-in. strip brass, 1-16 by ½ in., for brackets.





Above, Panel Template and Subpanel Layout; Below, Bracket Details and Photo of Oscillator Unit with Top of Can Removed

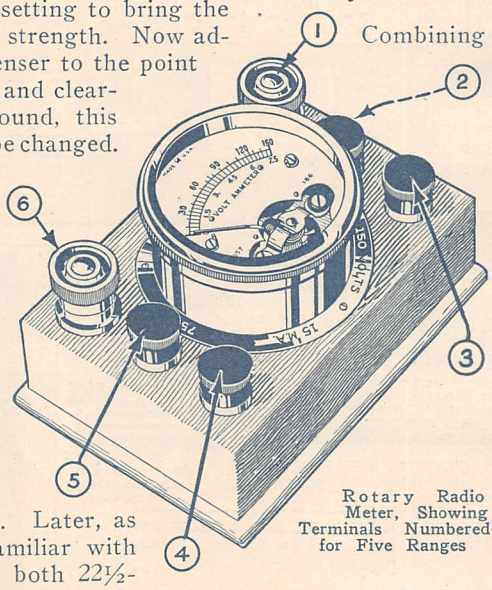
are then fastened to them with additional brass nuts. Note that the brass center bracket carries the common A and B-negative line, the A-negative line being completed through the push-pull filament switch.

Wire the circuit just as shown in the large wiring diagram, placing soldering lugs under all terminals; never solder directly to any instrument. Soldering lugs should be fastened to the fixed condensers by means of two short brass machine screws. Use a good grade of spaghetti tubing over any leads under the subpanel that would be likely to touch and cause a short. After the wiring is completed, connect all the batteries just as shown in the wiring diagram and turn on the filament switch; place one tube successively in each socket to test out the filament circuit; if all right, all tubes may then be placed in their respective sockets. The loop used should be of the three-tap box type and can be placed anywhere convenient to the set, keeping the leads reasonably short; the center loop lead is plugged into the center loop jack, the outside leads in the outside jacks. To test out the set, plug in the coupler coil

and place the rotor of the coupler at an angle of about 45°, replacing the lid of the can firmly so that it will not vibrate; plug in the loud speaker and turn on the filament switch. Turn the rheostat well over to the right, and keep the potentiometer as far to the left as possible for the first test. Slight changes in the rheostat and potentiometer settings will be required but the approximate positions are as given. To pick up a station, slowly rotate the dials in step, never tuning them independently when locating a station. When the signal is heard at good volume, leave the oscillator dial as it is and readjust the wavelength dial a few points on either side of the oscillator setting to bring the signal in at maximum strength. Now adjust the midget condenser to the point that gives the loudest and clearest signals. Once found, this adjustment need not be changed. For these first tests, which should be made when local stations are on the air, it is well to keep the B-battery voltage to the plates of the oscillator and detector tubes on both 22½-volt posts, and the resistance - coupled unit on 90 volts just as shown on the large wiring diagram. Later, as you become more familiar with the instrument, raise both 22½-volt B-battery connections to 45 volts and the 90-volt connection to 112½ volts. This B-battery arrangement will necessitate a more critical rheostat adjustment on the oscillator tube, but will bring out the full possibilities of the instrument. The arrangement of the tubes should not be changed except that the new 200-A or 300-A detector tubes may be used if desired. The first a.f. amplifier tube may be either a 201-A or a power type, but if a power tube is used, the ballast and negative grid bias must be changed to suit the tube specifications. Ample volume is obtained with the 201-A tube; therefore, it is recommended for the first a.f. stage. The .1-M resistor, clipped across the filament and grid posts of this socket is necessary regardless of the type of tube to be used.

Popular Mechanics radio laboratory has made every effort to make this set as simple to build as possible; all details have been carefully checked, and a set of enlarged blueprints of the wiring diagram, schematic diagram, full-size drilling templates, as well as additional photos of the subpanel layout and under-subpanel wiring have been prepared. The complete set may be obtained from Popular Mechanics Radio department, 200 E. Ontario st., Chicago, Ill., for 75 cents. Specify blueprint No. 114.

Rotary Radio Meter Has Five Ranges



Rotary Radio Meter, Showing Terminals Numbered for Five Ranges

Combining five ranges, a new radio meter of rotary design has appeared on the market. It can be used for all testing on receivers, tubes, batteries, battery chargers and battery eliminators. The meter is mounted on a mahogany block, and is turned by a knurled rim to the five different positions, registering with each of the binding posts through a series of segments within the base block. The No. 1 post is the positive terminal used for all measurements; No. 2 is the 7.5-volt scale, for testing tubes, filament voltages, and A-battery voltages; No. 3 is the 150-volt scale, for measuring plate voltages on tubes, and of B-batteries and B-eliminators; No. 4 is the 15 milamp. scale, for obtaining the plate current on single to three-tube sets, and for testing tubes; No. 5 is for the 75-milamp. scale for testing the plate current of large sets of four or more tubes or power amplifiers, and outputs of B-eliminators. The No. 6 post is for the 7.5-amp. scale for measuring the current taken by tube filaments, singly or in sets, and for charging A-batteries. Wiring diagrams are supplied with the meter for checking battery eliminators, coils and transformers.

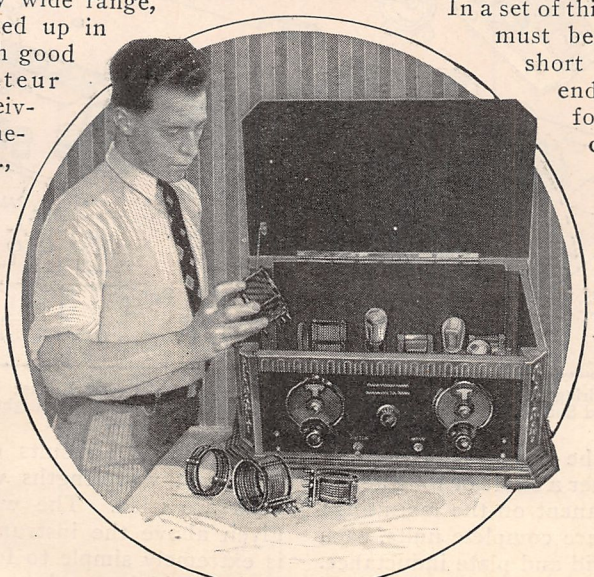
This Set Tunes from Fifteen to 550 Meters

By FRANK L. BRITTIN

ONE of the most interesting receivers Popular Mechanics radio laboratory has ever experimented with, is a simple three-tube set employing five interchangeable coils of the plug-in type. Bringing in distant stations on the short rebroadcast waves in the daylight as well as after dark, with great volume on the loud speaker, this set proved a real surprise. But it can be instantly changed over for the standard broadcast wavelengths as well by merely changing the coils.

Several of the larger broadcasting stations in this country as well as abroad are now sending their programs on two separate wavelengths. For example KDKA, Pittsburgh, operates on a regular wavelength of 309 meters and at certain times rebroadcasts the same program on 64 meters so that it may be picked up by its sister station KFKX, Hastings, Nebr., and rebroadcast on 288 meters. The short waves do not seem to be greatly affected by daylight or atmospheric disturbances and cover a very wide range, often being picked up in south Africa with good volume on amateur short-wave receivers. WGY, Schenectady, N. Y., broadcasts experimental programs at irregular intervals on waves between 15 and 105 meters; 2YT, Poldhu, Ireland, on about 94 meters with experimental programs, and G2-NM, London, on about 44 meters, is often heard after 11:00 p.m. Several of the Australian, European and South American stations may also be heard on waves between 30 and 50 meters.

The three-tube set to be described is easy to build, and, as the front panel is only 7 in. wide and 18 in. long, takes up very little space. The front-panel and subpanel layouts are clearly shown in the illustration on the color page; it is important that the detector-tube socket be of the shock-absorber type for eliminating microphonic noises. The grid condenser and leak are mounted in spring clips so as to be readily removable, one end of this mounting being screwed to the detector-socket grid post. For the short waves, a .0001-mfd. grid condenser and a gridleak of from 6 to 9 meg. will give the best results. On the ordinary wave bands, when using either of the two larger coils, better results will be obtained with a .00025-mfd. grid condenser and a gridleak of from 2 to 6 meg. resistance.



Completed Receiver, in Which Various Types of Interchangeable Coils Are Used

In a set of this type every effort must be made to obtain short leads. To this end, the a.f. transformers used are constructed with removable bands or brackets; the latter being reversed and the transformers turned upside down so as to bring the terminals close to the subpanel.

The base for the plug-in coils is shown in its proper position, and the primary coil mounted

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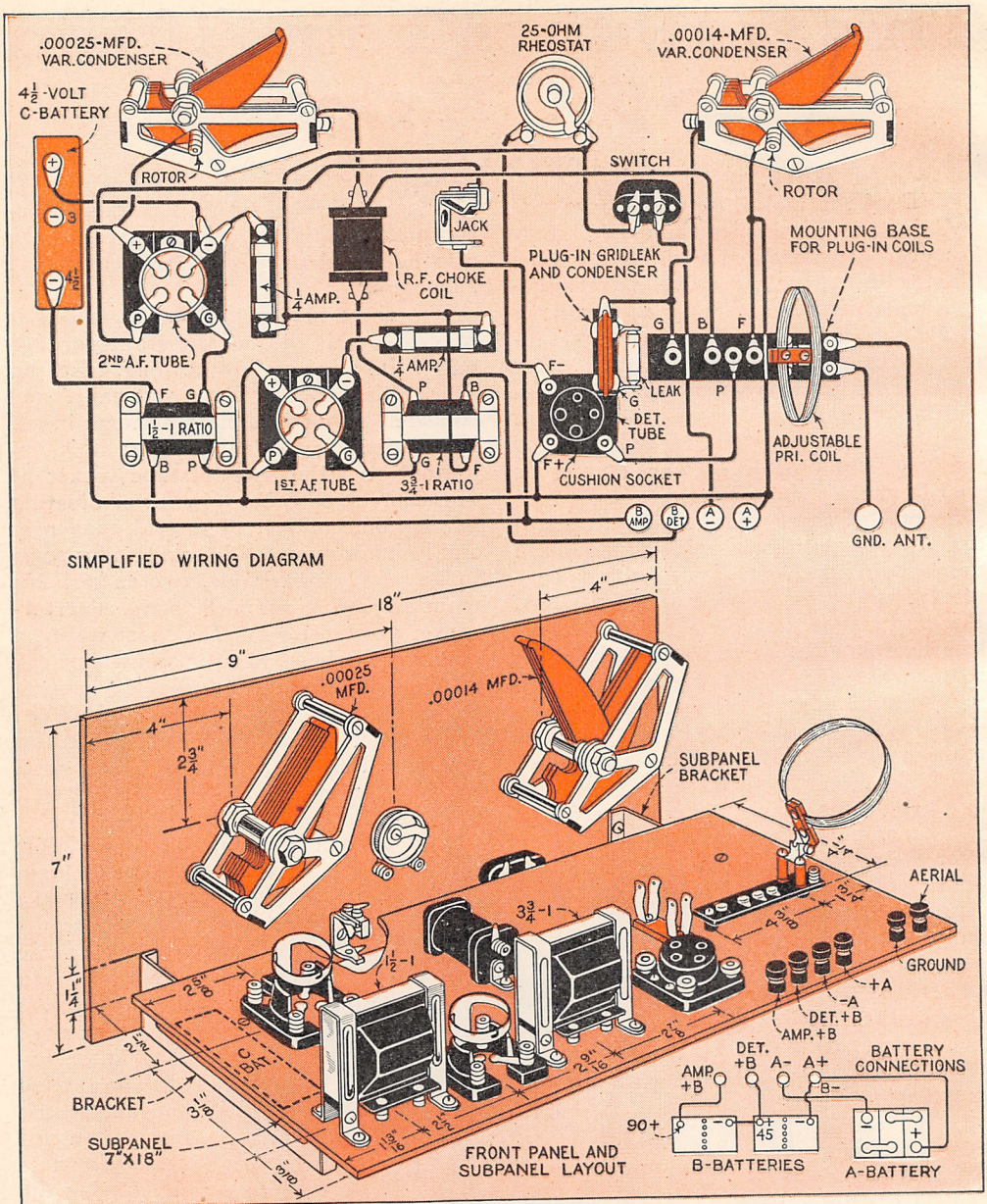
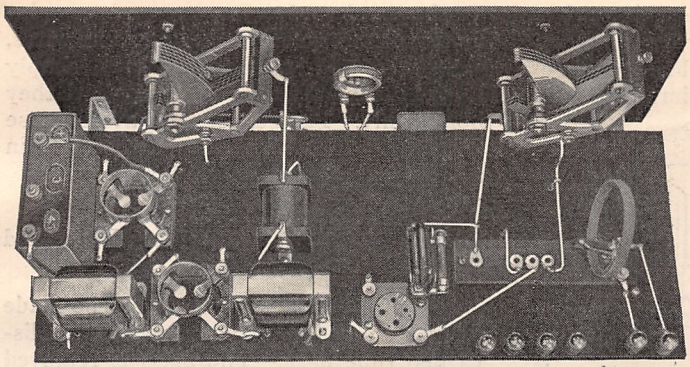
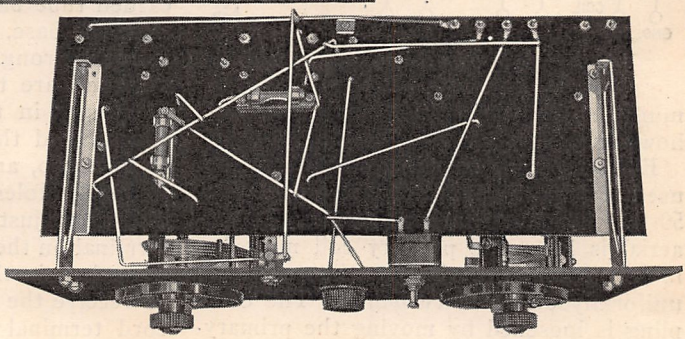


Above, Simplified Wiring Diagram, with All Instruments in Their Relative Positions; Below, Front-Panel and Subpanel Layouts with Battery Connections Shown at Lower Right

on this base may be adjusted for the best coupling with either a short or long aerial. This coil is permanent on the mounting; the plug-in coils are complete units, each consisting of a grid and plate inductance. The circuit used is of the "fixed tickler" capacity-controlled type, which is best suited for short-wave reception and also gives excellent results on the standard broadcast wavelengths when the proper coils are used. The wiring diagram is given above the instrument layout, and is extremely simple to follow. Soldering lugs should be used under all terminals. A schematic diagram is supplied for those who prefer it to the simplified form.



Looking Down on Subpanel; Right, Under-Subpanel View, Showing Ballasts and Method of Wiring



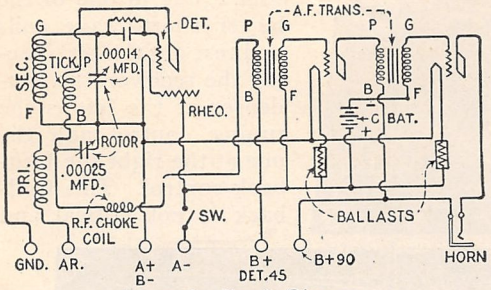
Before wiring the set, carefully examine the photos of the completed set; the upper one shows the method of running the wires through the subpanel, and the direction of these wires can be easily followed by referring to the under-subpanel view below. The rheostat controls the detector tube only, and ¼-amp. ballasts are used to control the filaments of both amplifier tubes. These ballasts are mounted on the underside of the subpanel by means of short brass machine screws. At the rear edge of the subpanel a strip of brass, 1/16 by ½ by 2½ in., bent to form a bracket, is mounted as a support for the subpanel at the center. If the set is to be mounted in a cabinet, see that there is clearance for the adjustable primary coil, so that, when placed in a horizontal position, it will not touch the side of the cabinet. Now, with the receiver wired and ready for operation, connect the batteries and place the tubes in the sockets. Three 201-A, or similar tubes, are used; plug in one of the larger short-wave coils and test out the set. Facing the receiver, the condenser at the left is the tuning control and the one at the right the feedback control. This feedback is not critical and the set will be found easy to tune. If the set howls, the capacity of the grid condenser must be raised and the value of the gridleak lowered.

When balancing the set, it is well to disconnect the aerial; then try various combinations of grid condensers and gridleaks, as tubes vary and short-wave sets are inclined to go into oscillation with a bang or howl, instead of the usual hiss. If the set is still "touchy" on the low waves, it may be necessary to change the detector, grid return, or bias, to negative instead of positive, as it now is. However, this is not likely to be necessary. When the best

MATERIAL LIST

1 front panel, 3-16 by 7 by 18 in.
1 subpanel, 3-16 by 7 by 18 in.
2 Benjamin subpanel brackets.
1 spring-suspended socket, X-type.
2 sockets, any good low-loss, X-type.
1 Jefferson a.f. transformer, type 41, 1½ to 1 ratio.
1 Jefferson a.f. transformer, type 41, 3.75 to 1 ratio.
1 Karas S.L.F. condenser, .00025 mfd.
1 Karas S.L.F. condenser, .00014 mfd.
1 Samson r.f. choke coil.
2 Daven ballasts, ¼ amp., or Amperites of same value.
1 open-circuit jack, short type.
1 25-ohm rheostat.
1 push-pull filament switch.
1 set Aero short-wave coils, 15 to 133 meters, complete with mounting base.
1 Aero coil No. 4, 125 to 250 meters.
1 Aero coil No. 5, 235 to 550 meters.
1 4½-volt C-battery, large type.
1 Sangamo fixed condenser, .0001 mfd.
1 Sangamo fixed condenser, .00025 mfd.
4 gridleaks, cartridge type, 2, 6, 7 and 9 meg.
1 combination grid condenser and leak mounting, removable-clip type.
6 binding posts with engraved tops.
4 2-ft. lengths of round, tinned-copper busbar wire.
3 doz. soldering lugs, long, round-hole type.
12 6-32 round-head brass machine screws, 1 in. long.
12 6-32 round-head brass machine screws, ½ in. long.
4 6-32 round-head brass machine screws, ½ in. long (nickelplated).

grid condenser and gridleak have been found, check the short-wave coils and make sure that the set can be made to oscillate smoothly from maximum to minimum on the tuning condenser, without howling.



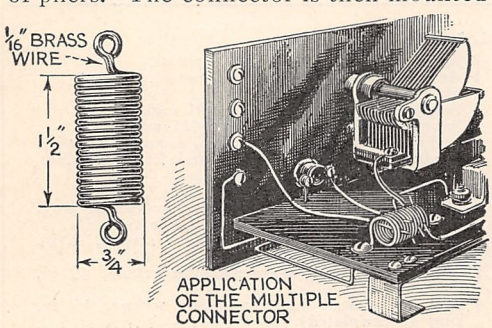
Schematic Circuit Diagram

Either a long or short aerial may be used for short-wave reception; one wire 50 ft. long gave excellent results. If the aerial is long, the primary coil must be loosely coupled or the set will not work uniformly on all wave bands. The coupling is loosened by moving the primary coil farther away.

A large wiring diagram may be had from Popular Mechanics Radio department, 200 E. Ontario street, Chicago, for 15 cents. Specify blueprint No. 115.

Handy Multiple Connector for Use in Experimental Circuits

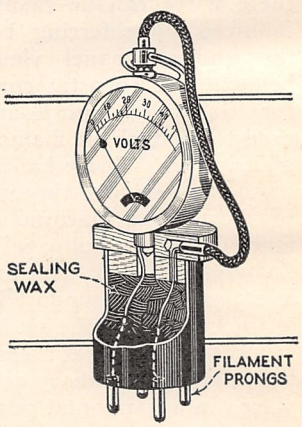
Multiple connectors for making quick connections in experimental hookups save time and enable the experimenter to try out a variety of circuits. They may be made of brass wire, wound in the form of a spring. The coils are closely spaced and the ends turned into eyes with a pair of pliers. The connector is then mounted on the baseboard at any convenient point by means of two small screws. The wires, terminals and connections are simply forced down between the coils, where they hold firmly. The best size for average use is made of 16-gauge brass wire, wound in a ¾-in. coil, about 1½ in. long.



Detail of Coil-Spring Connector, and Mounted on Set with Leads in Position

Socket Voltmeter Made from Discarded Tube Base

A useful socket voltmeter can be made from a small pocket voltmeter and a discarded tube base. The glass is removed from the base, leaving the wires from the filament prongs intact. Two small disks of wood are then turned down, one to fit snugly in the top of the socket, as shown, and the other slightly larger to form a cap, and the disks are glued together. Holes are then drilled in the disks, one just large enough to take the terminal on the case of the voltmeter, and the other, in the edge of the larger disk, to receive the cord terminal of the voltmeter. Small pieces of metal tubing, to which the tube-prong terminals have been soldered, are then forced into these holes. The inside of the tube base is filled with wax, which can be taken from the top of a discarded B-battery if desired. Before the wax has cooled, the wooden disks are forced down on top of and into the base. Forcing the voltmeter terminals into the metal-lined holes completes the instrument, and it may now be plugged into the sockets of the receiving set. The rheostat is then turned up until the voltmeter needle gives the proper reading for the tube that is to be used. Checking the tubes in this manner does away with all guesswork and greatly prolongs the life of the tube by removing the danger of excess filament voltage.—L. M. Curtis, Venice, California.



A Radio Cabinet of Striking Design

By EDWIN M. LOVE

THE unusual is achieved in the radio cabinet described here—beauty of design combined with strength and durability; yet so simple is the construction that the most inexperienced amateur can build it. While arranged especially for a 7 by 18-in. radio panel, a shorter one could be used by widening the battery boxes at the ends, or a longer, by extending the cabinet itself. The speaker shell is for a 12-in. cone speaker. (See Fig. 1.)

The front panels of the battery boxes, detailed in Fig. 2, are simple rectangles of 1-in. stock, carefully squared to 6 by 8 in. On the face side of each, cut a rabbet, 3/16 in. deep (or whatever thickness the panel is) and 1/4 in. wide; and remembering that the two must be made as a pair, chisel out a notch in the upper end 1/2 by 1/2 by 3/4 in., to carry the ends of the loose upper rail.

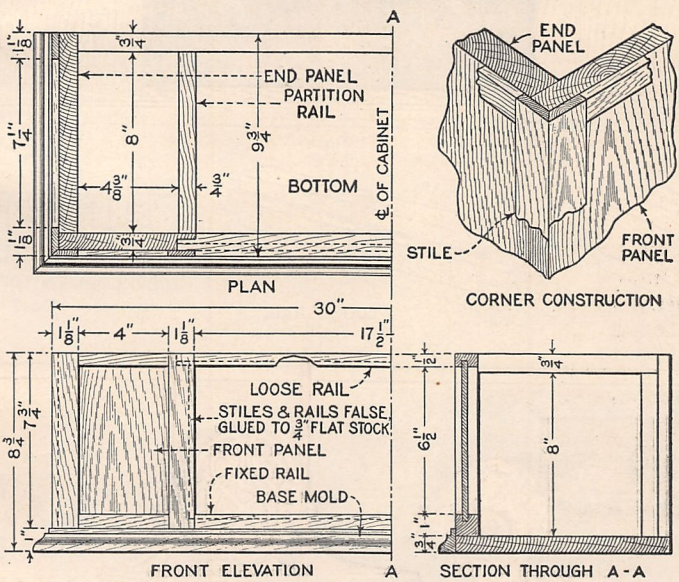


FIG. 4

The two end panels, shown in Fig. 3, are 3/4 by 8 3/4 by 8 in. Make the back of pine, 3/4 by 8 by 28 in., and the bottom, 3/4 by 9 3/4 by 30 in.

Nail the ends to the back and the front panels to the ends, inclining the nails in various directions to increase their holding power, and the bottom to the lower edges, allowing it to project 1/4 in. at the ends and front; or, if preferred, tack the parts together and insert 3/8-in. hardwood dowels in holes bored from the outside.

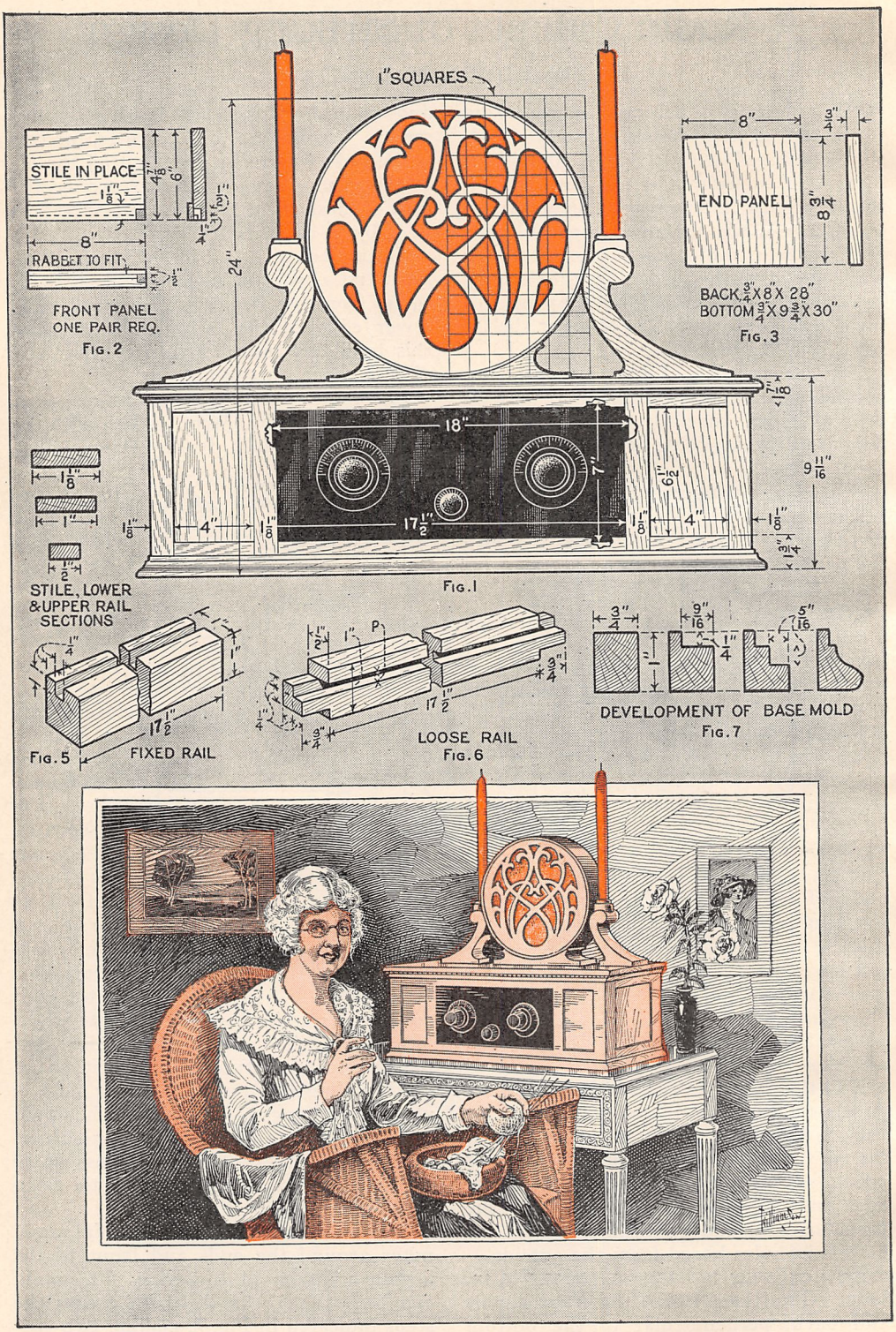
Now cut four 3/4 by 3/4-in. strips, 7 1/4 in. long. Glue these inside the front panels and back, perpendicular to the bottom and 4 1/2 in. from the ends, inside measurements. Apply glue to both parts, for this is the only way to be sure that all the effective gluing surface is used. Across the tops of these cleats glue and nail spreaders of 3/4 by 3/4-in. stock.

Cut a piece of 1 by 1-in. net stock, 18 in. long, and plow a 3/16-in. groove, 1/4 in. deep, 1/4 in. from the front face, to receive the lower edge of the bakelite panel. Cut this to fit between the front panels, and glue in place on the bottom.

For the vertical panel strips or stiles, use stock 1/4 in. by 1 1/8 in. Flush with the panel edge of each front battery panel, glue on a stile; and glue flush with the back edges of the end-pieces their stiles. These need only be weighted in place until the glue is dry. Nails are unnecessary. For the corners, miter one edge of each to fit. Tack these in place by toe-nailing from the top ends and through the lower ends where the base mold will cover them. Allow one member to dry before gluing on its mate.

Now glue the upper and lower rails in place, using stock 1/2 in. wide for the upper and 1 in. for the lower. Cut these pieces long enough to require firm pressure to force them back, but not so tightly as to crush the edges of the stiles.

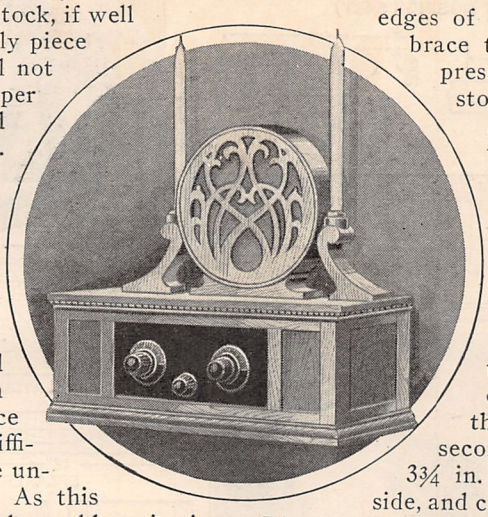
When all is dry, smooth the joints, and miter around the ends and front of the bottom a base mold, 1 in. wide. This mold can be made by hand, by following the steps indicated in Fig. 7, making two suc-


1"SQUARES
STILE IN PLACE
RABBET TO FIT
FRONT PANEL
ONE PAIR REQ.
FIG. 2
END PANEL
BACK ¾"X 8"X 28"
BOTTOM ¾"X 9¾"X 30"
FIG. 3
18"
17½"
FIG. 1
STILE, LOWER
& UPPER RAIL
SECTIONS
FIXED RAIL
FIG. 5
LOOSE RAIL
FIG. 6
DEVELOPMENT OF BASE MOLD
FIG. 7

cessive rabbets and finally working out the curved part, or a suitable mold may be purchased at a picture-framing shop.

Make a loose rail, as in Fig. 7, 19 in. long, ½ by 1 in., with a 3/16 by ¼-in. groove ¼ in. from the face edge, and a ½ by ½-in. tenon centered on each end.

The lid is ¾ by 9¾ in. by 2 ft. 6 in. It can be made of solid stock, if well seasoned, but a five-ply piece is far better, as it will not warp. Only the upper side need be figured material (see Fig. 8). Make a ½ by ¾-in. nosing mold, which is mitered around the ends and front, dropping down from the top face 3/16 in. to show a margin. This may be tacked with 1-in. brads, driven through the cove, since otherwise it is quite difficult to keep it in place until the glue is dry. As this leaves a thin edge of the mold projecting below, the surface must be built up by gluing to the underside a 3/16 by 1-in. strip, running it all around. The back strip carries the hinges.



Make the speaker grill of ⅜-in. three-ply stock. Lay out a piece of tracing paper, 7 by 14 in., in 1-in. squares, and, following the intersections shown in Fig. 1, draw one-half the design. Notice that all lines of the stems are continuations of the rim circles and tangent to them. No two stems are the same width, and they vary in width throughout their length. The leaves spring from the stems on a tangent.

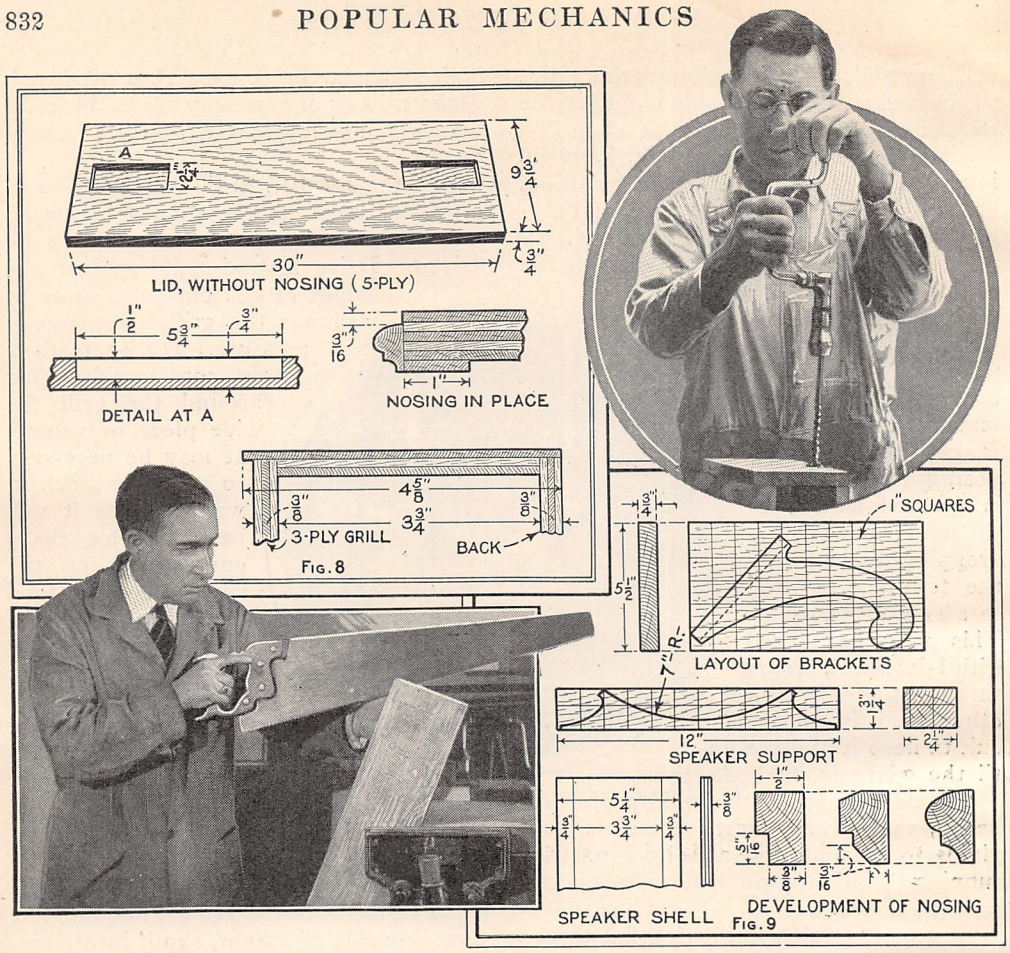
Draw a 14-in. circle on the stock, and divide with a vertical diameter. Trace the half design, turn the pattern over, and trace the other half. Bore holes through each part to be removed and use a bracket saw to cut them out. Smooth the edges with a fine file and sandpaper, being careful not to chip the corners.

Obtain three strips of ⅛-in. veneer, 45 in. long, one 5¼ in. wide, the others 3¾ in. If veneer is hard to get, gauge a piece of 1-in. stock, and ripping alternately from one edge and the other, cut a thickness. Smooth the stock, and repeat. Plane off high spots in the veneers thus produced. Make a back of three-ply stock, 14 in. in diameter, and cut out a disk 12½ in. in diameter.

Lay the finished grill, face downward, on ⅜-in. strips on the shop floor, or on some other surface where nails can be driven. Drive several nails against the edges of the cut-outs, so as to brace the grill for edgewise pressure. Have ready a stout cord, and bend around the grill the wide piece of veneer. It may be necessary to soak the stock in water before it will bend to the sharp curve. Cut off the surplus length and bind the cord around the veneer until it is drawn tightly against the grill edge. Bend a second piece of veneer, 3¾ in. wide, around the inside, and cut off the extra length. The joint need not be closer than 1/16 in. Bend a third piece of the same length and width inside of that.

Now take out the liners and coat the inside of the outer veneer with liquid glue. Coat one side of a liner, slip it into place, with the joint at the top, coat it inside, and coat the third piece, which in turn is put inside. They will not fit snugly together at this stage and the upper edge will be lopsided. Press the liners down against the grill, and slip in the back disk. Bind the veneer tightly against this, as well as the grill, which should bring it to a disk throughout. Then slip blocks, 3 in. wide, through the opening, press to the sides and wedge up with other blocks, until the veneers are well clamped together. Weight the assembly to eliminate possible twists, and allow to dry thoroughly.

After the glue has set, remove back, grill and clamping blocks. If there are any appreciable openings between the layers of veneer, mix thin glue with plaster of paris and run down into the spaces. Cover the back of the grill with tightly stretched silk, or fine-mesh bronze screen, using ¼-in. tacks to hold it on, and glue the grill into the shell. The back is held



on with small screws after the speaker is installed. Joint off the shell until the projection is ⅛ in., and round the corners.

Make the bracket pattern as shown in Fig. 9. If the brackets are to be sawed out by hand, use 1-in. stock, make six, and round off the corners of the curves to a radius of ⅛ in. Glue together in groups of threes. Smooth with a file and sandpaper. If they are cut with a bandsaw—any mill will cut them very cheaply—glue up the three thicknesses before cutting. The speaker support is made from stock 1¾ in. net by 2¼ in.

Lay out the upper surface of the lid for the bracket mortises, 2¼ by 5¾ in., 1 in. from the ends, and centered on the width. Stand the brackets on these spaces and trace around with a fine-pointed pencil. Then, with a sharp chisel, cut ⅛ in. inside, and hollow out to a depth of ½ in.; trim to the line, trying the brackets occasionally to see if they fit. Size the ends, and glue into the mortises.

Center the speaker support between the brackets, gluing and nailing it, and boring for the wires. Put the shell in position, and nail it to the support. A tack may also be driven into each bracket.

To furnish sockets for the candles, fit to the tops of the brackets pieces of 1½-in. round stock, bored with ¾-in. holes.

Remove all traces of glue, and sand well before staining. This design is suitable for either plain or two-tone finishing, or for gesso and polychrome work.

¶Squeals and howls caused by body capacity may be eliminated by shielding the back of the front panel with tin or copper foil. This foil must not short any instrument; ground the shield and the cores of the amplifying transformers to the negative terminal of the A-battery.

Correct C-Battery Voltage Important

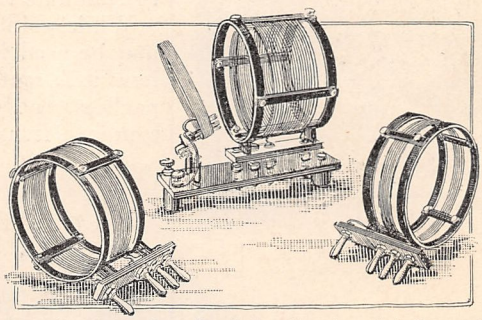
Correct C-battery voltage in the audio-amplifier circuit of any receiver is important. The battery should have the proper voltage in order that the amplifier tubes may receive the correct grid bias; an incorrect value will cause distortion. The C-battery voltage should be increased if the B-battery voltage is raised, as in the practice of adding a power tube in the last stage. Assuming that the normal total B-battery voltage was 90 before the power tube was added, and a 4½-volt C-battery was used, the power tube should have a plate voltage of 135 and at this voltage a 9-volt C-battery must be used. The proper C-voltage for the tube is specified by the manufacturer and should be followed carefully for best results.

Model House Wired for Radio

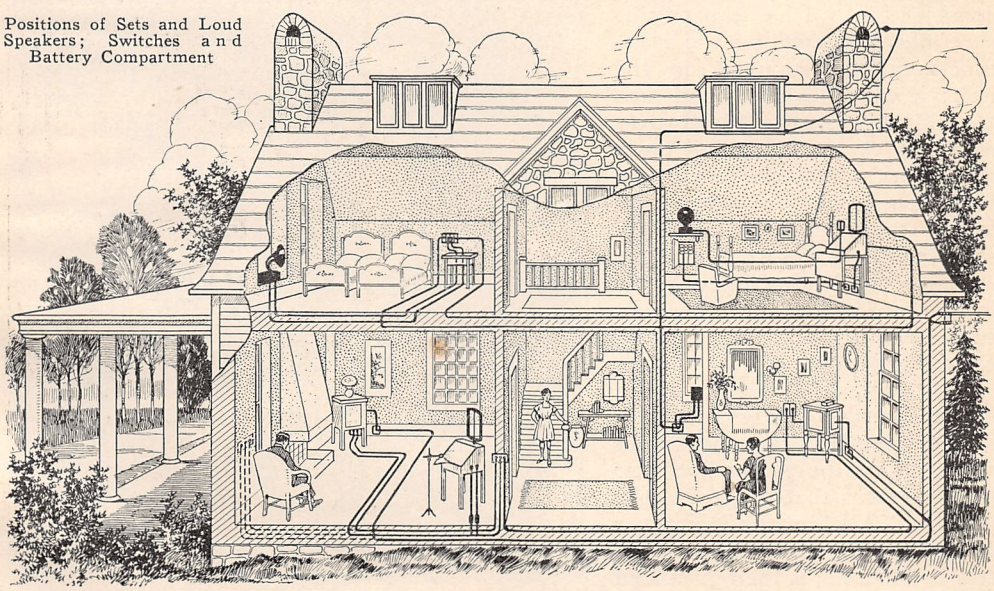
This model home, correctly wired for radio, was recently designed by one of the large radio manufacturers. The positions of the various sets and loud speakers as well as the method of wiring are clearly shown in the illustration. Note the outlets in the baseboards, and the remote-control switches and battery compartment on the second floor. The loud speaker, in the living room, may be plugged into the porch circuit if desired. The aerial, from the point where it enters the building, is inclosed in conduit in the walls. Many new homes and apartment buildings are now being wired for radio, and this model home was designed for the purpose of properly guiding the builder.

Plug-In Coils for Short Waves

Plug-in coils are now available for short-wave receivers. The set shown in the illustration consists of three interchangeable coils and a mounting on which is placed an adjustable primary coil. The coupling of the primary coil may be set for best results with either a long or short aerial. The interchangeable coils each have a grid and plate inductance and cover a range from 15 to 130 meters. Coils to 550 meters may be obtained if desired.



Interchangeable Plug-In Coils, Showing Coil Plugged into Mounting at Rear



Positions of Sets and Loud Speakers; Switches and Battery Compartment

Fixed-Condenser Kinks

By WM. CALVERT

THE fixed condenser is a necessary adjunct to most receiving circuits, but the part it plays is not always clearly understood by the average builder. They are often used at random by the experimenter, many times with surprising results. When properly used, fixed condensers are a specific remedy for many inefficient sets and may also be used to eliminate troublesome interference.

While pointing out the various purposes for which they may be used, it may be of interest to take one apart and see how it is made. Available in all sorts of shapes and capacities, the construction is practically the same in all types; alternating sheets of tin or copper foil and mica, make up the unit, the capacity depending on the size and number of the metallic sheets, the kind of insulating material and the method of construction. The capacity is carefully measured by the manufacturer and stamped on the unit; if carefully made and protected from moisture this capacity does not vary. The small types shown in the illustration are specially designed for radio use; larger types capable of withstanding high voltages may be used for eliminating interference from electrically operated devices, such as electric fans, motors and battery chargers.

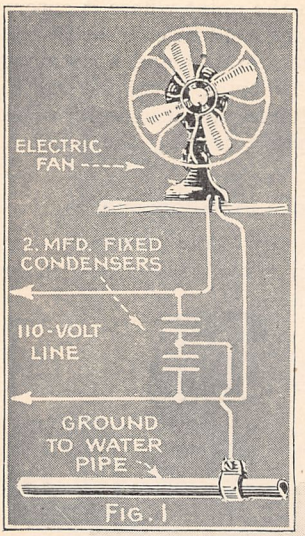
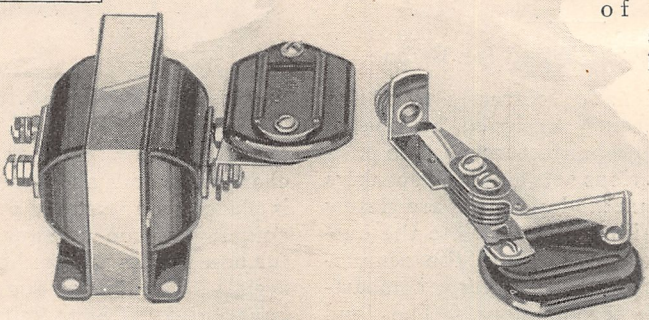


FIG. 1



The method is clearly shown in the illustration, Fig. 1; two 2-mfd. condensers are connected in series across the power line near the apparatus that is causing the trouble. The center point, or common connection between the two condensers, is then grounded

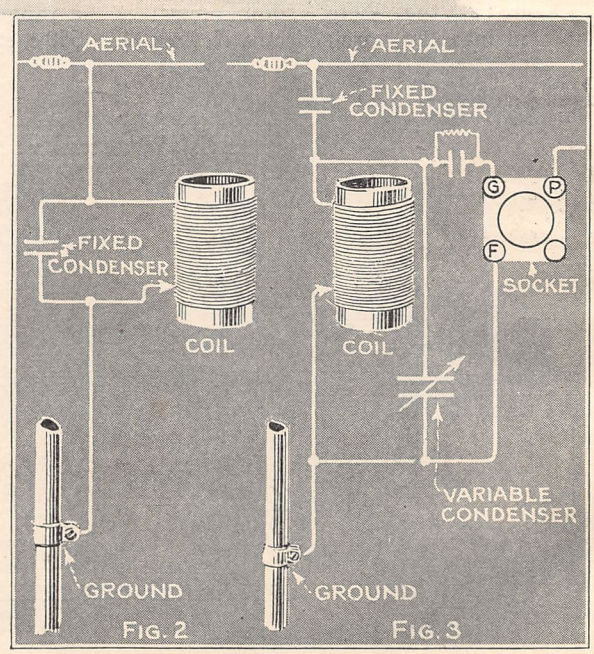
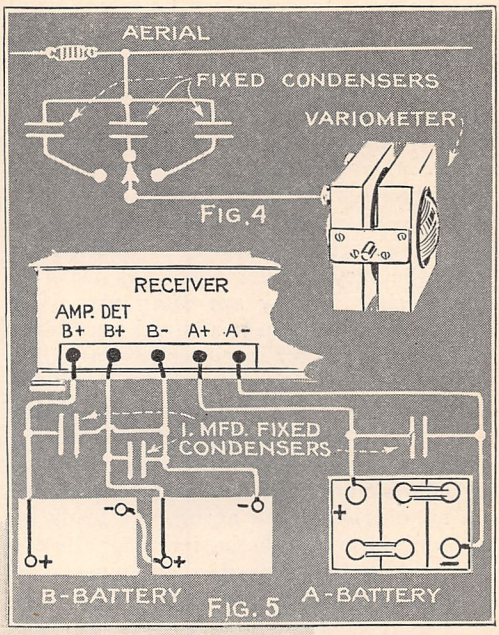
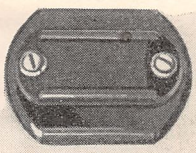
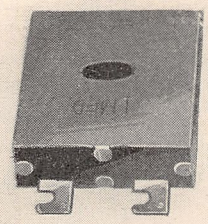


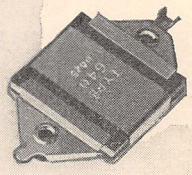
FIG. 2 FIG. 3

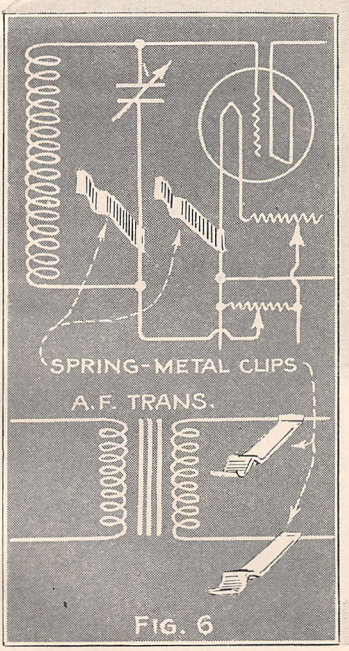
to a water pipe, as shown in the diagram. When connecting fixed condensers of the small type in radio sets, never apply the iron directly to the condenser; use soldering lugs and fasten them to the condenser by means of short brass machine screws. If the condenser is to be fastened to some piece of apparatus, such as a transformer, it is advisable to use short metal strips drilled to take the binding posts and machine screws, as shown in the photo. A .0005-mfd. condenser placed across the secondary of the last a.f. transformer will often eliminate the high-pitched whistle in the loud speaker caused by the a.f. amplifier. In some cases it is advisable to place the condenser across the primary of the transformer; try both positions for best results. Shunting the loud-speaker jack with a condenser, as shown at right, will often give better results in tone, permitting the speaker

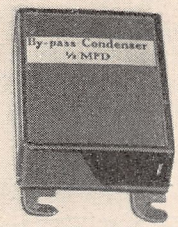


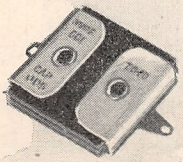












to reproduce a wider range of frequencies; this condenser may be .001 to .006 mfd.

The experimenter often wishes to reduce or increase the capacity of variable condensers, or change the inductance value of coils; this is easily done with fixed condensers. By shunting a fixed condenser across the inductance, as shown in Fig. 2, the wavelength of the circuit will be raised; if this condenser is variable the wavelength may, of course, be varied at will. However, in most cases, with simple sets, it is only necessary to raise the wavelength to a certain point and a fixed condenser of suitable capacity may be used as shown.

For reducing the inductance value of a circuit for shorter wavelengths, a fixed condenser

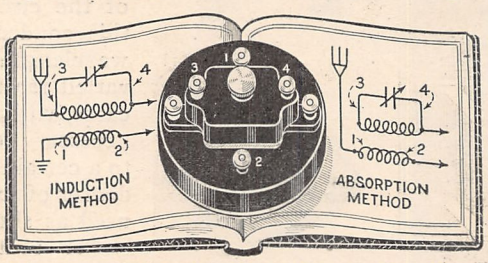
may be used in series with the coil and antenna, as shown in Fig. 3, and even more flexibility may be obtained by employing several capacities, as shown in Fig. 4, a switch being used to change from one capacity to the other. In tuned circuits of this type such a method is advised to easily adapt the set to aerials of various lengths. It is common practice now to place the various batteries at a distance from the set in order that they may be out of sight. They are often placed in the basement or in a near-by closet; long leads are necessary in either case and the result is a loss of selectivity as well as noisy operation due to the pick-up of the leads. This may be remedied by the use of fixed condensers for by-passing the various batteries; these by-pass condensers should be placed across the leads at the set and not at the batteries, or the effect will be lost. By-pass condensers of either .5 or 1 mfd. may be used for this purpose. Fixed condensers are not expensive; they are one item used in the construction of a radio set that has dropped lower in price than any other. In the early days precision condensers cost as high as $25; now even better units may be obtained for from 40 to 75 cents.

The capacities required for most circuits are always specified, although the experimenter often finds that a greater or less capacity than that specified is needed. The change of capacity required, may be due to the experimenter's location, the use of parts other than those called for, or the placing of parts on the baseboard. In cases of this kind, it is usually necessary to try a number of condensers before the correct capacity is found. To facilitate this testing operation, a pair of small clips, made of light spring metal, may be bent in the form shown in Fig. 6 and soldered to the busbar wires, thus doing away with the necessity of soldering and unsoldering each condenser tried.

All fixed condensers are not adaptable to this method, but for those that may be clipped in and out of the circuit, these little clips are very useful. If the condenser is constructed so that it cannot be used in this manner, short lengths of busbar wire may be soldered to the circuit leads instead of the clips; lugs are then soldered to the ends of the short wires so that the condenser may be screwed in position with short brass machine screws. It is a simple operation to remove the screws and put in a condenser of different capacity.

Device Designed to Reduce Interference and Static

A small instrument designed to assist in tuning the set so as to eliminate interference and reduce static has appeared on the market. It is especially recommended for warm-weather reception when static interference is most prevalent. It is composed of a tuning coil which is balanced by a small variable condenser, providing an additional means of tuning for any tube or crystal set, excepting sets which are operated on a loop. The numbered terminals on the instrument are for the various connections given in the diagrams. One way of using the unit is by induction and the other by absorption; the latter method is advised for the reduction of static, although it slightly reduces the volume. The induction method will assist and improve the volume, it is claimed.

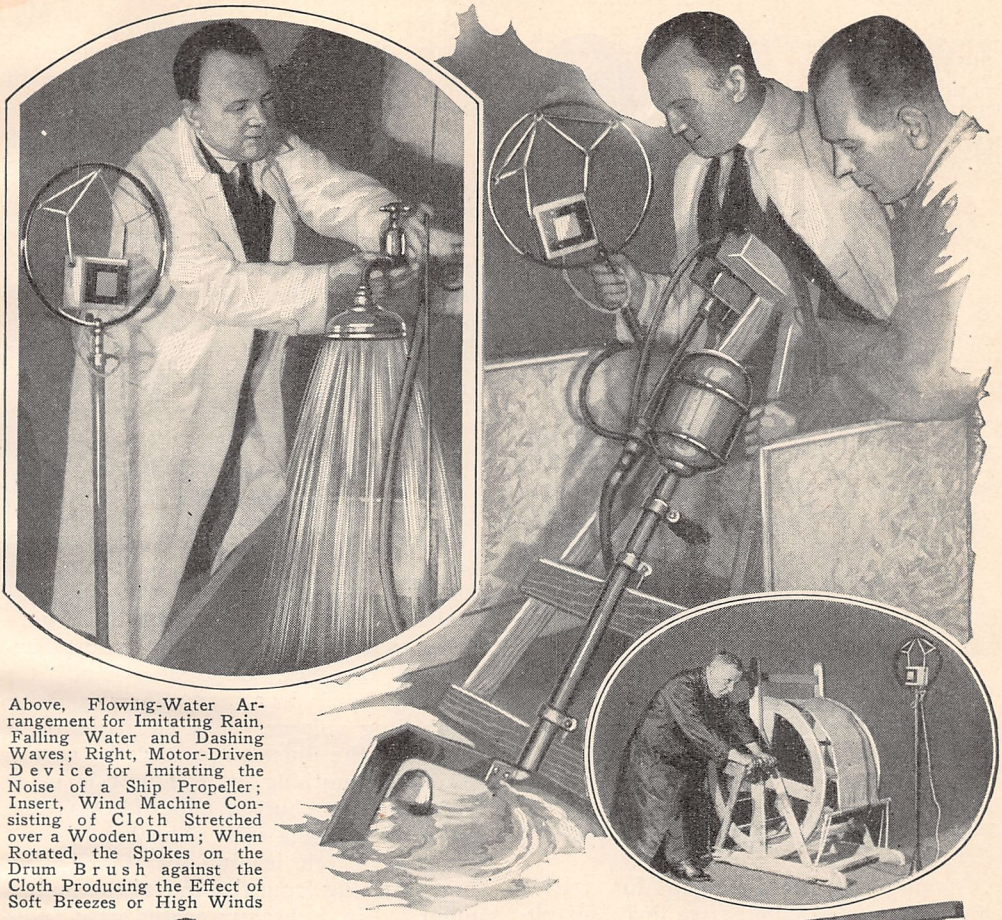


Interference-Eliminating Device, Showing Two Ways in Which It May Be Used

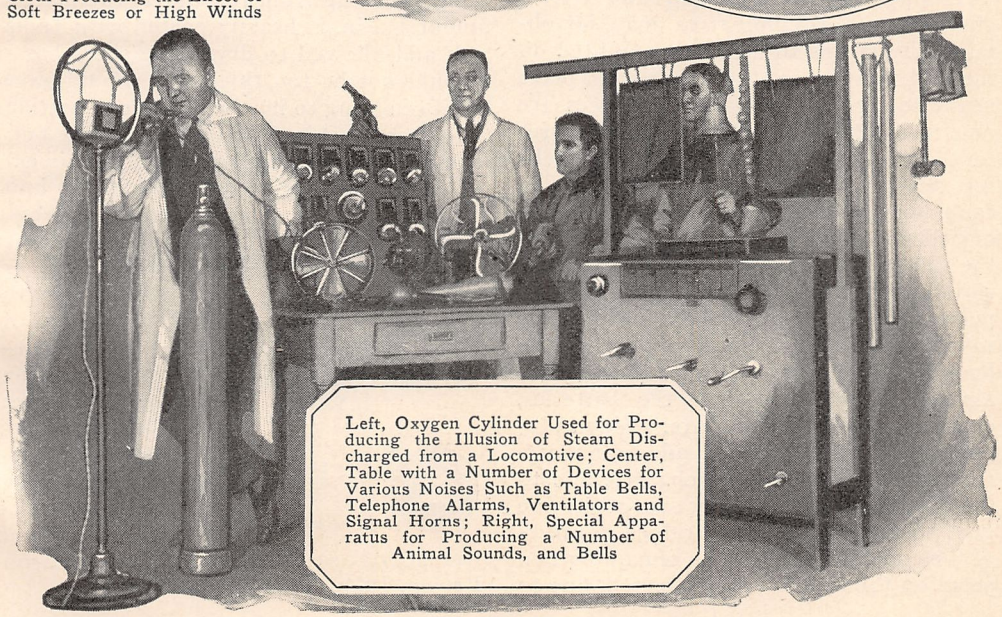
Testing Dry-Cell Batteries

Dry cells vary in amperage according to the make, but the usual cell should register from 30 to 35 amp. when fresh. An ammeter should be used for testing dry-cell A-batteries, and is to be left in the circuit just long enough to obtain the reading. Care should be taken that the meter is connected properly. If connected backward, the pointer will be deflected off the scale in the wrong direction. If the reading is below 10 amp., the cell is worn out.

MAKING THE GERMAN RADIO PLAY REALISTIC

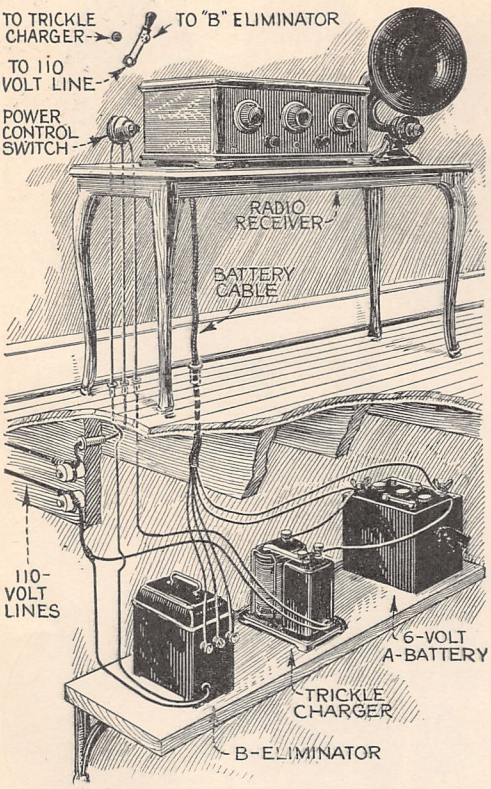


Above, Flowing-Water Arrangement for Imitating Rain, Falling Water and Dashing Waves; Right, Motor-Driven Device for Imitating the Noise of a Ship Propeller; Insert, Wind Machine Consisting of Cloth Stretched over a Wooden Drum; When Rotated, the Spokes on the Drum Brush against the Cloth Producing the Effect of Soft Breezes or High Winds



Left, Oxygen Cylinder Used for Producing the Illusion of Steam Discharged from a Locomotive; Center, Table with a Number of Devices for Various Noises Such as Table Bells, Telephone Alarms, Ventilators and Signal Horns; Right, Special Apparatus for Producing a Number of Animal Sounds, and Bells

Simple Power-Control Switch

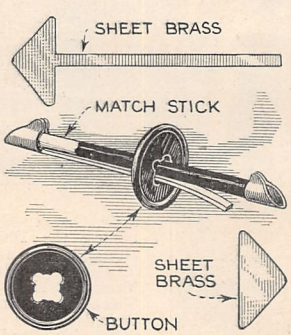


Simple Power-Control Switch for Trickle Charger and B-Eliminator with Connections

A simple power control for trickle chargers and B-eliminators may be obtained by means of a switch mounted on the wall, or at some other convenient place near the set. Power-control devices are now on the market, but for those who prefer to make their own, this simple switching device will give good service. The equipment consists of a three-point switch, of either the snap or push-button type, and the illustration shows the connections clearly. The switch lever and contact points merely illustrate the action of this snap switch and are not a part of the hookup. If the house has a cellar, it is always desirable to place the batteries, charger and eliminator there. When tapping the 110-volt line, one side is connected directly to the trickle charger, and to the B-eliminator; the other side of the line goes to the post on the bridged contacts of the control switch. The remaining two posts on the switch are connected, one to the other input wire on trickle charger, and the second to the wire on the B-eliminator. With a snap-switch the eliminator and charger will alternate on or off with each snap of the switch. If the flush push-button type of switch is used, pressing one button will shut off the charger and connect the eliminator, in which position the set can be operated. Pressing the other button will shut off the eliminator and connect the charger. It will be seen that the filaments of the tubes must be operated independently by the filament switch on the set, or by turning the rheostats to the off position, if the set is not equipped with a switch.—E. J. Bachmann, Fullerton, Pa.

Button and Match Make Variable Gridleak

The radio fan can always find use for a variable high resistance; and nothing could be simpler to make than the unit shown in the drawing. It can be used either as a gridleak or for the resistance-coupled amplifier. It is also handy for stopping howls in a.f. amplifiers, and for controlling volume. The construction is shown in the illustration, and the cost is practically nothing, as the unit is made from a match, a button, a bit of brass sheet and a little India ink. The head is cut from the match, leaving the stem 1¾ in. long; starting from the end of the match, about 1¼ in. is heavily coated with India ink and allowed to dry. The sheet brass should not be too thick and should have a bit of spring to it; the manner of cutting and shaping it is clearly shown. The button is ½ in. in diameter and a hole is cut or drilled in it as shown. When the unit is completed, sliding the button up or down changes the amount of brass in contact with the inked surface and thus varies the resistance. The unit is remarkably quiet and has proved satisfactory in use.—Watson Brown, Iuka, Miss.



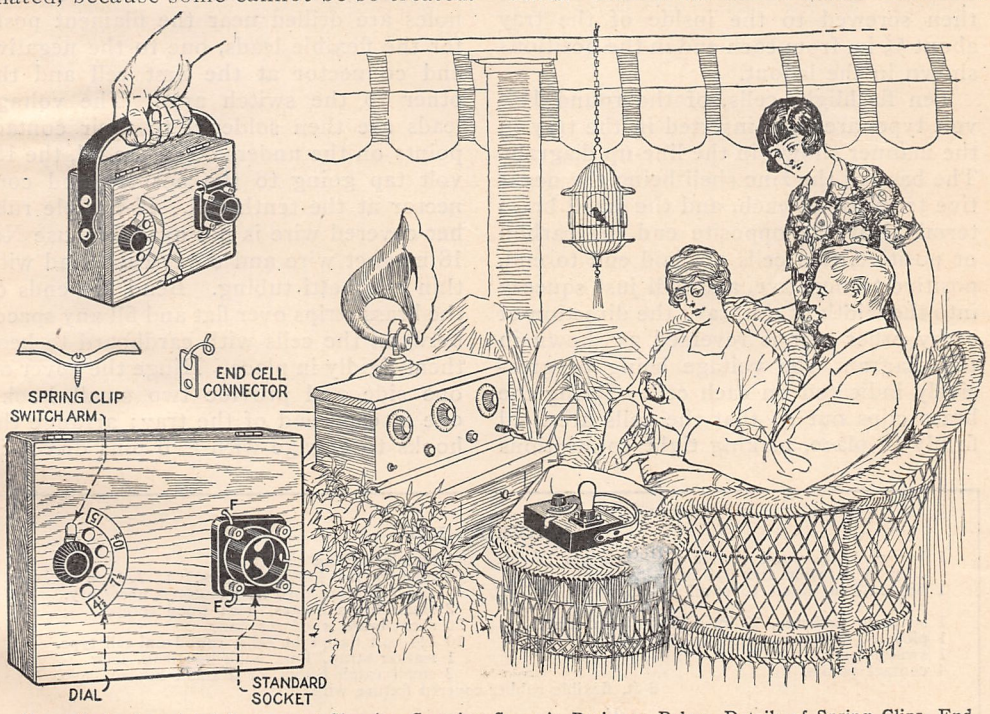
How to Build a Portable Tube Booster

By L. B. ROBBINS

AFTER the apparent death of seven UV-199 tubes, I began to look around for some means of reviving them for further use. Rejuvenators of various types are on the market, but all require a 110-volt lighting circuit and this was not available.

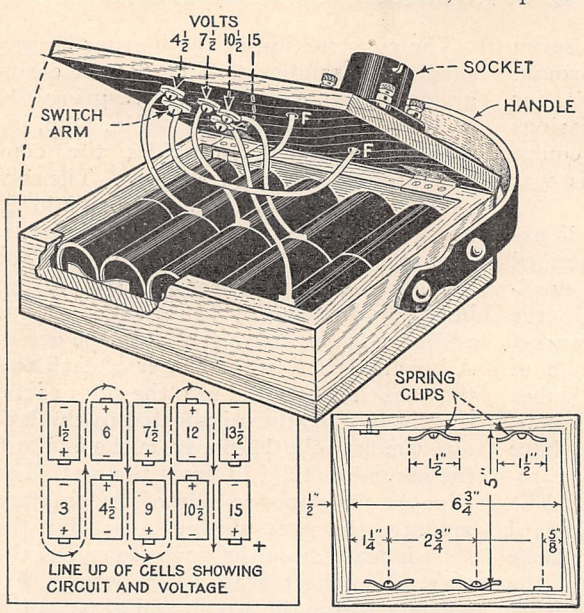
The problem was solved at small expense by the simple apparatus described in this article. It operates from ten flashlight cells, may be easily carried in the hand or slipped into an overcoat pocket and will restore to efficiency a tube of either the 199 or the 201-A type. Tubes with shorted grids and filaments, of course, are beyond recall, but where they have lost their original "pep" they may be restored to usefulness in a short time. The instrument is provided with a standard socket and adapter so that either the large or small tubes may be handled; if the tubes are of the new X-type, the X socket should be used. Make sure that your tubes are of the type that may be rejuvenated, because some cannot be so treated.

The construction of the booster is very simple. A shallow tray or box of clear-grained ½-in. soft wood, measuring 6¾ in. long by 5 in. wide and 1⅝ in. high, inside measurements, provides the container for the ten flashlight cells. The corners must be square and there should be no metal projections of any kind inside. The over-all dimensions of the cover are 7¾ by 6 in.; four pieces of stiff spring brass, 1½ in. long by ½ in. wide, are cut and bent in the shape shown in the detail. A hole is drilled in the center of each and they are then screwed into the sides of the tray in the positions indicated in the layout, the first clip 1¼ in. from the end and the second one 2¾ in. from the first. The clips on the opposite side of the tray are mounted the same distance apart, but the start is made from the opposite end of the tray. Use short brass wood screws that will not pierce the wood, and arrange the clips horizontally so that they will make the necessary connections for the dry-cell units. Two brass end-cell connectors are



Upper Left, Completed Instrument Showing Carrying Strap in Position; Below, Details of Spring Clips, End Connectors and Close View of Top; Right, Timing Tube under Treatment

then cut from the same stock, ½ in. wide and 1 in. long, and a short length of flexible wire is soldered to each connector, as shown. These terminal connectors are then screwed to the inside of the tray about ⅝ in. from each end in the positions shown in the layout.



Above, Lid Partly Raised, Showing Battery Connections; Cut-Out Section at Front Shows Spring Clip in Position; Below, Line-Up of Cells and Layout of Tray

Ten flashlight cells, of the round 1½-volt type, are then inserted in the tray in the manner shown in the line-up diagram. The base of the zinc shell being the negative terminal of each, and the small brass terminal at the opposite end the carbon or positive, two cells are laid end to end, positive to negative, and will just squeeze into the width of the tray; the direction of every other pair is reversed as shown in the diagram, the voltage being progressively indicated on each cell. Spring the brass clips out so that the cells are held firmly in place, making tight connections to the terminals. This line-up will bring one end connector against the negative pole of the first cell, and the other against the positive terminal of the end, or tenth, cell. Three thin brass connectors, 1 in. long and ½ in. wide, with a short piece of flexible wire soldered to each, are slipped between the cells for the voltage taps to the switch points, at 4½, 7½ and 10½ volts, the 15-volt tap being the lead from the positive end terminal. The three voltage connectors are placed between the third and fourth, fifth and sixth and seventh and eighth cells, respectively. The switch arm is mounted 1 in. from the end of the cover, and the four switch contacts as shown in the view of the top of the finished instrument. Care should be taken to let them project as little as possible on the underside of the lid. Glue a small arc of white bristol board or celluloid close to the taps, and mark the various voltages as shown.

The tube socket is mounted at the other end of the lid and two small holes are drilled near the filament posts for the flexible leads, one to the negative end connector at the first cell and the other to the switch arm. The voltage leads are then soldered to their contact points on the underside of the lid, the 15-volt tap going to the positive end connector at the tenth cell. If flexible rubber-covered wire is not available, use No. 18 magnet wire and cover each lead with thin spaghetti tubing. Bend the ends of the brass strips over flat and fill any spaces between the cells with cardboard to keep them rigidly in place. Hinge the cover on one side and provide two small hooks, one at each end of the tray; arrange the hooks to engage with two pins driven in

MATERIAL LIST

1 box of ½-in. wood (inside measurements 1⅝ in. deep, 5 in. wide and 6¾ in. long).
1 lid of ½-in. wood (over-all dimensions 6 by 7¾ in.).
1 strip spring brass, ½ in. wide by 8 in. long.
1 piece of thin brass sheet, ½ by 3 in.
1 switch lever.
4 contact points.
1 standard tube socket.
1 adapter for 199-type tubes. If X-type sockets and tubes are used no adapter is necessary.
2 small brass hinges, with wood screws.
20 short brass wood screws.
10 1½-volt flashlight cells, round uni-cell type.
1 leather strap, 1 in. wide by 16 in. long.
2 small catch hooks, or a small hinged hasp.
2 ft. flexible rubber-covered fixture wire.

the ends of the cover so as to hold the lid tight down on the tray when closed. A small, hinged hasp may be substituted if desired. If there is any play between the lid and the cells use felt or cardboard to pack the cells firmly. The leather carrying strap may be made from an old belt and is fastened with short wood screws in the manner shown in the illustration, thus completing the instrument.

Left, Eight-Tube Neutrodyne, Showing Method of Shielding; Above, Comparison in Size and Type of Early Crystal Set with the Single-Control Receiver

To rejuvenate a tube, place it in the socket with the switch arm off; then with your watch in hand, flash the tube by placing the switch arm on the voltage indicated for that particular tube. For the UV-199 or C-299 tube, the flash should be on 10½ volts for 45 seconds. At the end of this period bring the switch arm back to the 4½-volt tap and leave it there for 10 minutes. Replace the tube in the set and, if the tube does not show the required improvement, repeat the process. The UV-201A and C-301A tubes should be flashed at 15 volts for 45 seconds and then burned at 7½ volts for 10 minutes. While the life of the small dry cells composing this unit is not long enough for use in a commercial way for tube boosting, the amateur who has only a few tubes to rejuvenate occasionally will be well served by the instrument. When the cells go dead, they should be removed quickly and fresh ones inserted.

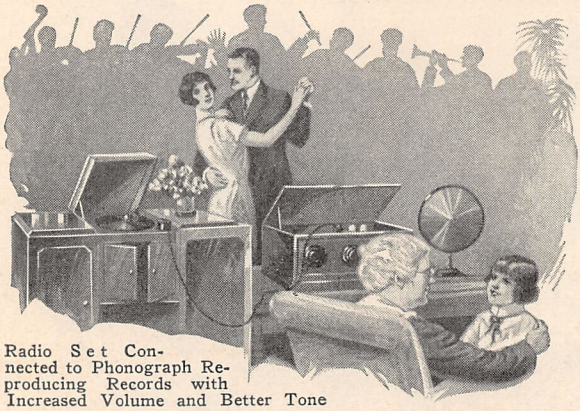
¶The homemade battery charger described in our October issue is for 110-volt, 60-cycle alternating current only, not for 100-volt, as erroneously stated on page 657.

One-Control Neutrodyne Works on Loop

This eight-tube receiver of the neutrodyne type may be operated with one hand, through a precision single-control mechanism in the form of a bakelite disk which, by means of a vernier gear, turns a rotary drum bearing a wavelength scale. This one tuning control takes the place of ten ordinary adjustments and eliminates the necessity of expert knowledge in the operation of an elaborate receiver of this design. The set will work with either a loop, indoor or outdoor antenna. Copper shielding is used for the r.f. stages and the detector tube, and a steel compartment is provided for the a.f. stages. Metal caps above the assembly are removable for the purpose of inserting various tubes in their proper sockets. A double-range voltmeter is located below the control unit, and an eight-position switch permits the operator to note instantly the A, B, and C-voltages applied to the various parts of the circuit. New engineering features are claimed to eliminate distortion, insuring great volume combined with excellent tone and selectivity and ease of operation.

New Device Combines Phonograph and Radio

A new device combining the phonograph with the radio set is now available.

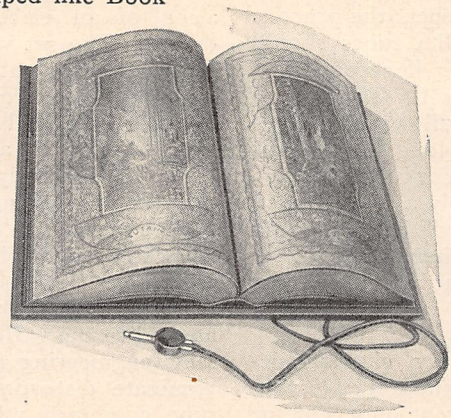


Radio Set Connected to Phonograph Reproducing Records with Increased Volume and Better Tone

The instrument is connected to the tone arm of the phonograph and a flexible cable, terminating in a specially designed plug, is inserted in the radio set. The record is played in the usual manner and amplified by the radio set, and the combination is claimed to give exceptionally good results. It has the advantage that favorite tunes can be played at any time with the full tonal value of the radio, and can be regulated fast or slow to suit the listener. Actually, the phonograph becomes the broadcasting station, so that all the advantages of radio tone are obtained without interference from static or other atmospheric disturbances.

Loud Speaker Shaped like Book

A new loud speaker of unusual design is made in the form of an open book. It has tinted pages done in sepia, is finished in gold and brown-morocco leatherette and has an artistic appearance. It rests on a small easel but may be hung on the wall if desired. It employs an electromagnetic unit applied tangentially to the edge of the curved membrane. This method differs from the usual pistonlike action directed at right angles to the surface. The speaker has a width of 17½ in. and is 13½ in. in height.



Loud Speaker, in the Form of Book with Illuminated Pages, Resting on Easel

Length of Aerial Important

In a large measure the performance of the set depends on the length of the aerial. The time has passed when the 100-ft. aerial was advised for all sets. As a general rule, the longer the aerial, the greater the signal strength, although the interference is amplified in the same ratio, and the set becomes sluggish. Also, the long aerial tends to absorb energy from the set, and has the effect of loading the circuit, preventing oscillation. The good results that are obtained by the long aerial are discounted by preventing the tuning of the modern set to the very low wavelengths, now in general use. For these waves a short aerial is required, and has the effect of adding energy to the set, also increasing selectivity. The aerial must not be too short, however, or the set will not operate. The proper length will be found by experiment. The height of the aerial depends on the location, and should be at least 20 or 30 ft. above the ground, the higher the better. For receiving purposes a single-strand aerial is just as efficient as the multiple-strand type. A good suggestion for the average set is to use three different aerials; a short one of about 40 ft. of the horizontal type, for stations below 300 meters; another about 70 ft. for the higher wavelengths, and one of the inside type for local stations. The latter may consist of two or more turns of bell wire around the room, behind the picture molding; a switch can be arranged for cutting in any one of the three aerials as the occasion may demand.

Three-Tube Set Works on Loop

Ideal City Set Is Selective, Operates Loud Speaker and Gets Rid of Aerial Nuisance

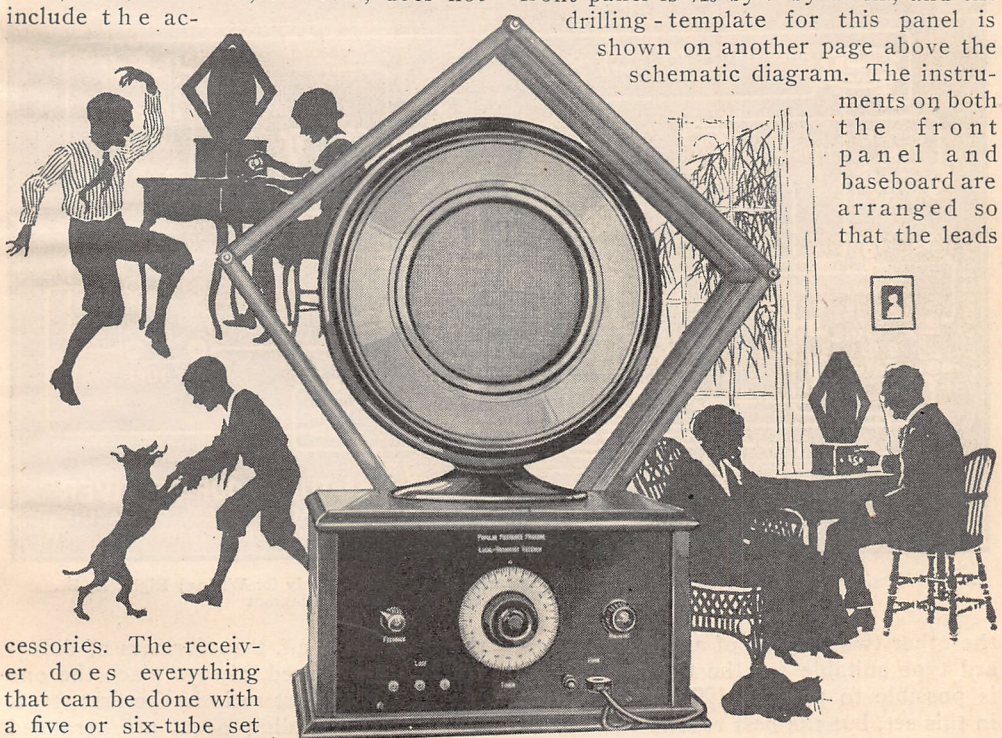
By FRANK L. BRITTIN

THIS little receiver is designed to fill a particular need and, for good performance at low cost, is in a class by itself. One often overhears a remark that runs something like this, "I would like to build a small set that would be selective enough to separate the powerful local stations, work on a loop, and have good loud-speaker volume; I am not interested in distance, as the local stations have excellent programs."

At first thought this seems like a rather large order, but Popular Mechanics radio laboratory now offers just such a set, thoroughly tested, that has excellent tone and good loud-speaker volume. The standard parts, shown in the layout, cost but $28.80; this cost, however, does not include the accessories. The receiver does everything that can be done with a five or six-tube set except that the range is limited to about seventy-five miles. In addition, it works on a loop instead of the usual outside aerial; no ground wire is required, and it is extremely simple to tune.

Although it is always best to follow material specifications closely for maximum results, this is one set where some latitude is permitted; with the one exception that the variable condenser must be of the type specified or similar type that has not a "live" shaft. The a.f. transformers may both be 3 to 1 or 3½ to 1 ratio, or as specified; the other parts will usually be found around the average experimenter's worktable or can easily be obtained from the nearest dealer in radio supplies.

The simple layout is clearly shown on the blueprint page and the battery hook-up is shown in the circle at right. The front panel is 3/16 by 7 by 14 in., and the drilling-template for this panel is shown on another page above the schematic diagram. The instruments on both the front panel and baseboard are arranged so that the leads may be kept short. The detector-tube socket must be of the cushioned type, but



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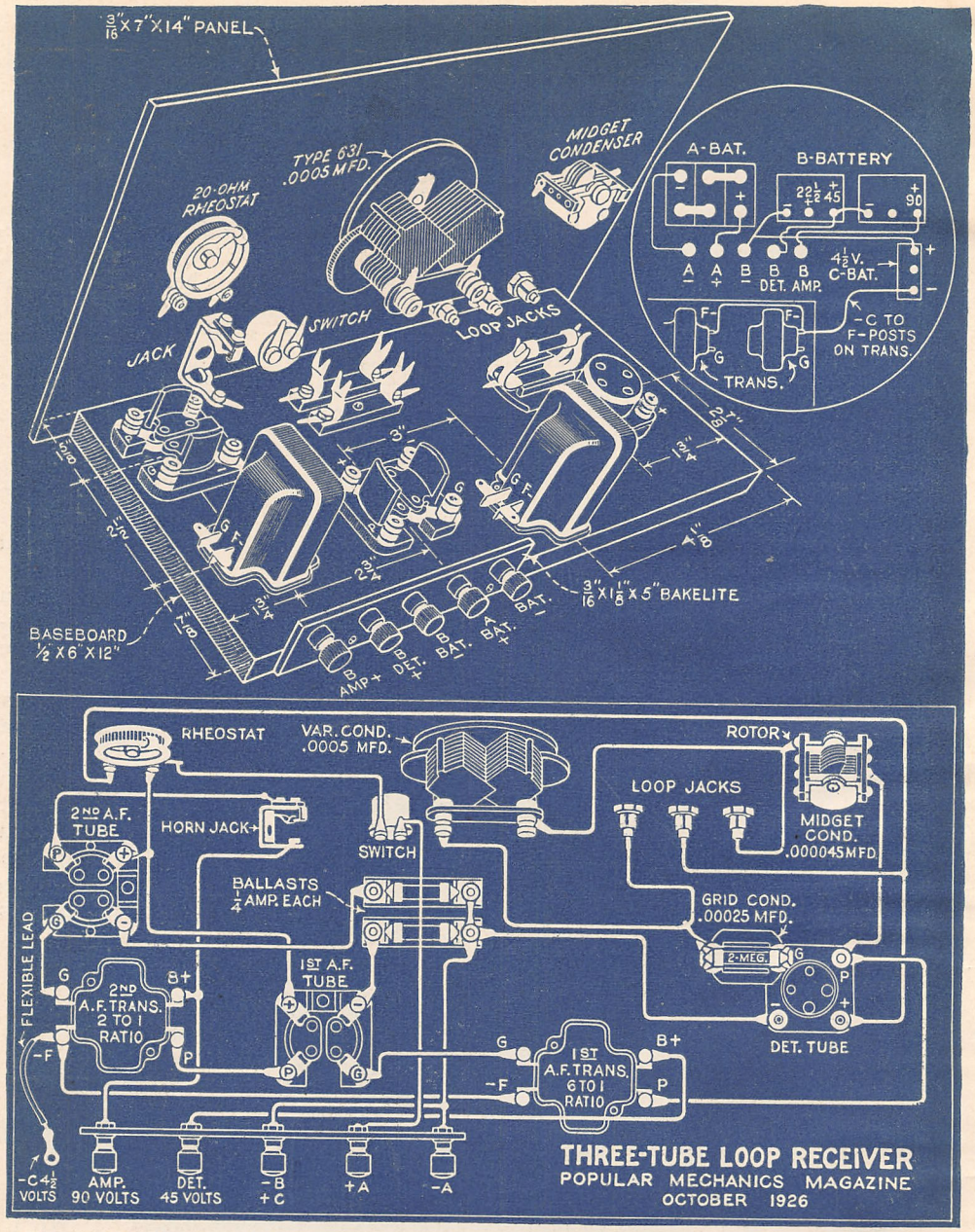


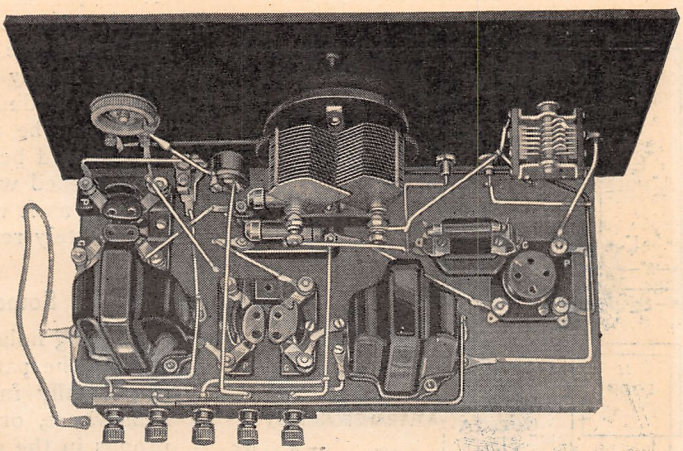
Above, Panel and Baseboard Layout Showing All Instruments in Position Ready for Wiring; Right, A, B and C-Battery Connections; Below, Simplified Wiring Diagram

the other two may be of any good standard type suitable for the tubes used. It is possible to use the 199 dry-cell tubes in this set, but the best results will be obtained with the standard 201-A type. One of the new 200-A or 300-A detector tubes may be used if desired, without changing the circuit. If a.f. transformers of different ratios are used, always place the one having the highest ratio in the first stage. The battery binding posts are arranged on a strip of bakelite, 3/16 by 1⅛ by 5 in., this strip being screwed to the rear edge of the baseboard as shown in the layout

diagram. Place soldering lugs of the long round-hole type under all terminals before starting the wiring.

The wiring diagram is given below the instrument layout and is so simple that little instruction is necessary. Follow the point-to-point connections carefully, and be sure that the rotor plates of the midget condenser are connected just as shown. It will be noted that the two ¼-amp. ballasts are connected together at one end and the lead taken to the negative-A post and to the negative post on the detector-tube socket. One ballast controls the filament of the first a.f. tube and the other the second a.f. tube, the detector tube being controlled by the 20-ohm rheostat. Use round tinned-copper busbar wire for the circuit and spaghetti tubing only where necessary to prevent shorts. The F-posts on the a.f. transformers are connected together, and the flexible lead, shown in the wiring diagram, is taken to the negative terminal of a 4½-volt C-battery, the positive lead from this C-battery running to the negative-B post that is common with the A-negative in the wiring diagram. This small C-battery takes up little room and may be placed in the cabinet with the set. The grid condenser and gridleak are mounted directly on the G-post of the detector-tube socket.

Check the wiring carefully and when completed, connect the A-battery and turn on the filament switch. Place one tube successively in each socket to test this circuit; if OK, turn off the switch and remove the tube. Now connect the B and C-batteries and place all three tubes in their respective sockets. The loop plugs are then inserted in the small jacks, taking care that the center loop lead goes into the central jack. Finally, plug in the loud speaker and the set is ready. Turn on the filament switch and slowly rotate the large condenser dial; if a station squeal is heard, adjust the midget condenser until this squeal is eliminated, bringing in the station clear with the large condenser. The detector-tube rheostat is then adjusted for best results, and one station after another can be brought in by slowly rotating the large condenser. After the correct setting of the midget condenser has been found, it will not be necessary to readjust it for every station. The loop will be found directional and usually gives best results when turned toward the transmitting station. This is not always the case, due to deflection from near-by metallic bodies.

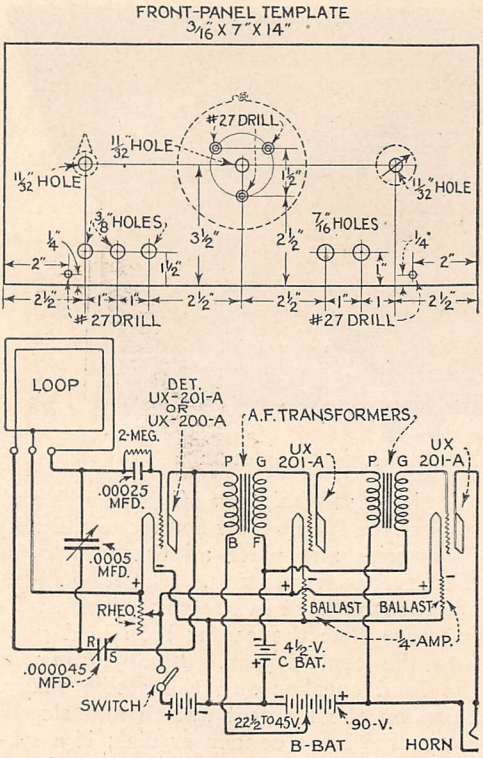


Rear View of the Completed Set

This is a set that any child can tune and

MATERIAL LIST

1 panel, 3-16 by 7 by 14 in.
1 baseboard, ½ by 6 by 12 in.
1 20-ohm rheostat.
1 open-circuit jack, short type.
1 push-pull filament switch.
1 Remler capacity unit, .0005 mfd., type 631.
1 midget condenser, .000045 mfd.
3 midget loop jacks and plugs.
1 X-type tube socket, spring-suspended or cushioned type.
2 X-type sockets, any good make.
2 Daven ballasts, ¼-amp. each, complete with mountings.
1 grid condenser, .00025 mfd., with gridleak clips.
1 2-meg. gridleak.
1 a.f. transformer, 6 to 1 ratio.
1 a.f. transformer, 2 to 1 ratio.
5 binding posts with engraved tops.
1 bakelite strip, 3-16 by 1⅛ by 5 in.
1 4½-volt C-battery, large type.
2 45-volt B-battery units.
3 UX-201A or C-301A tubes.
36 soldering lugs, long round-hole type.
3 2-ft. lengths round tinned-copper busbar wire.
1 length good black spaghetti tubing.
1 three-tap loop, box-type preferred.



Front-Panel Drilling Templates, and Below, Schematic Diagram of the Set

the results are really remarkable for a loop set employing but three tubes. The razor-edge sharpness of tuning makes it an excellent auxiliary set for the big-city listener who may have a much larger set for the DX-programs. A large set, unless it be a superheterodyne, is not necessarily one that tunes sharply; in fact, very few large sets even of the tuned r.f. type are selective enough to separate the high-powered locals under all conditions.

A large blueprint of the layout and simplified wiring diagram, may be obtained from Popular Mechanics Radio department, 200 E. Ontario st., Chicago, for 15 cents to cover postage and packing. Specify blueprint No. 116.

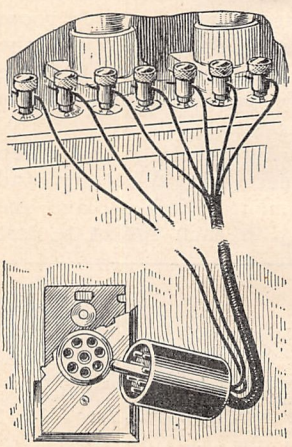
Alcohol for Cleaning Panels

Avoid water when cleaning radio panels or any part of a radio receiver. If the panel gets dirty or greasy, dampen a soft cloth with alcohol and rub it lightly over the surface to be cleaned. This will remove the dirt and grease, then dry the panel with another cloth. The alcohol will evaporate quickly without damaging the set in any way, and will leave a high polish. Ordinary household rubbing alcohol can be used for this purpose, but care should be taken not to spill any on the polished woodwork of the cabinet or console, as it will ruin the varnish unless immediately removed.

Some Radio Troubles

Clicking noises, heard when one presses against the panel or subpanel of a radio set, usually indicate a loose connection somewhere, or a faulty contact of tube prongs in the sockets. A loose or faulty grid connection usually betrays itself by a peculiar peanut-wagon whistle, which may also be due to leaky by-pass condensers, faulty transformers or loud-speaker cords. Grating noises, heard when turning the condensers, are often caused by touching condenser plates, which should be adjusted. In manufactured sets having sockets riveted firmly to the subpanel, the shells are sometimes a little too large for the tube base and the tube prongs do not make a good contact with the spring prongs in the sockets. Bend the latter up with a piece of wood and insert the tube carefully.

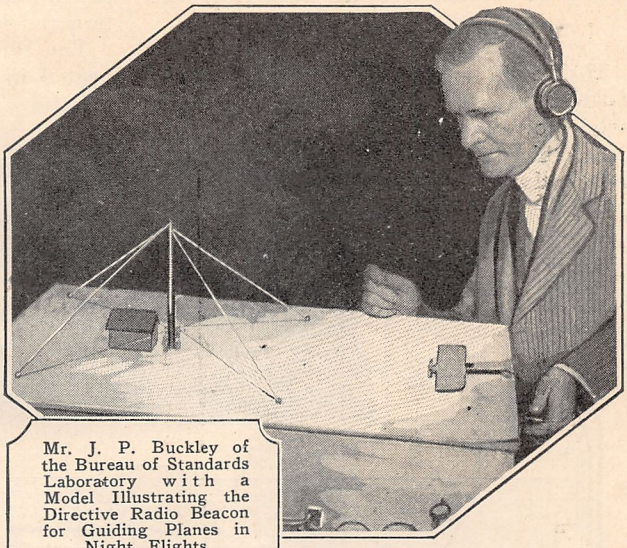
Wall Socket for Radio Batteries



A handy wall socket for the standard multiplug battery-cable is now available. The socket is mounted in the wall at a point convenient to the set, and the leads are run to the batteries, preferably kept in the basement or an adjoining room. The corresponding leads from the plug are taken direct to the binding posts on the set, as shown in the illustration.

RADIO NEWS FROM FAR AND NEAR

Pilot of Passenger Airplane Operating between Croydon, Eng., and Bourget, France, Equipped with Wireless Telephone for Safety Communications. Right, Two Japanese Misses with Parasol Receivers

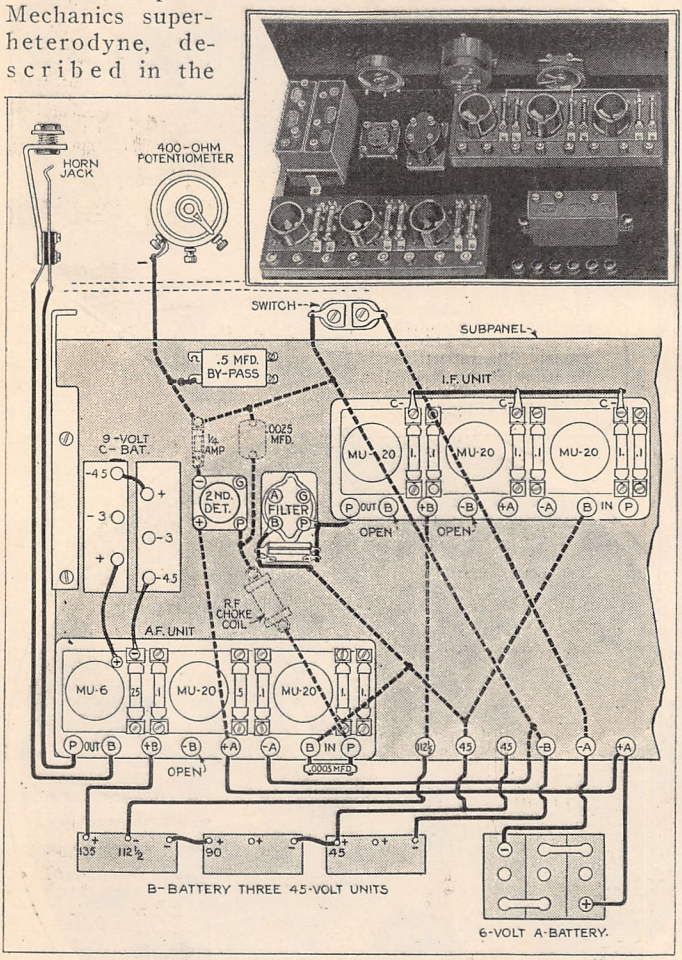


Mr. J. P. Buckley of the Bureau of Standards Laboratory with a Model Illustrating the Directive Radio Beacon for Guiding Planes in Night Flights

Left, Japanese Performer before the Microphone in Station JOCK at Nagoya, Japan; This Station Serves Japanese and Chinese Listeners and Is Often Heard as Far as California

Using Resistance-Coupled A.F. Amplifier in 1927-Model Superhet

If desired, resistance-coupled a.f. amplification may be employed in the 1927-model of Popular Mechanics superheterodyne, described in the October, 1926, issue, and as many of our readers who have such amplifier units may wish to use them in the new set, we have prepared the accompanying wiring diagram, to show necessary alterations in the circuit. The photo at the upper right shows the changes in the layout, with the a.f. unit in position at lower left, but neither the wiring diagram nor the photo shows any other parts or wiring than those involved in the changes. The dotted lines indicate the wiring under the subpanel; the fixed condenser, choke coil and ballast, also mounted under the subpanel, being dotted in to show their location and facilitate the work.



The two 4½-volt C-batteries are connected in series for the necessary 9-volt C-battery required for the MU-6 power tube in the last stage. These C-batteries are located directly in front of the unit and are held in position with two short brass brackets, and a small strip of wood or bakelite is employed to wedge them in position. It will be noted that the A-battery connections to the a.f. unit are taken direct, as the MU-tubes have 6-volt filaments and are lighted directly from the 6-volt A-battery; the A-battery circuit being completed through the switch to the B-negative post that is common with the negative-A. A 1-meg. resistor is substituted for the usual .1-meg. in the first input clip of the a.f. unit. In some cases it will be advisable to use 2 meg. but greater volume is obtained with the smaller value. Before connecting the 9-volt C-battery to the unit, be sure to remove the connector strip between the small binding posts on the front edge of the unit. The various B-battery voltages are marked on the binding posts in the diagram and must be used as shown for best results. The volume of the set may be controlled by the oscillator rheostat, or by a modulator horn plug.

The October, 1926, issue, containing the complete article, may be obtained from Popular Mechanics Magazine, circulation department, 200 E. Ontario st., Chicago, at the usual price, 25 cents. The complete set of original blueprints, full-size drilling templates and additional photos are available from our radio department for 75 cents. Specify blueprint No. 114.

Tips on Jacks

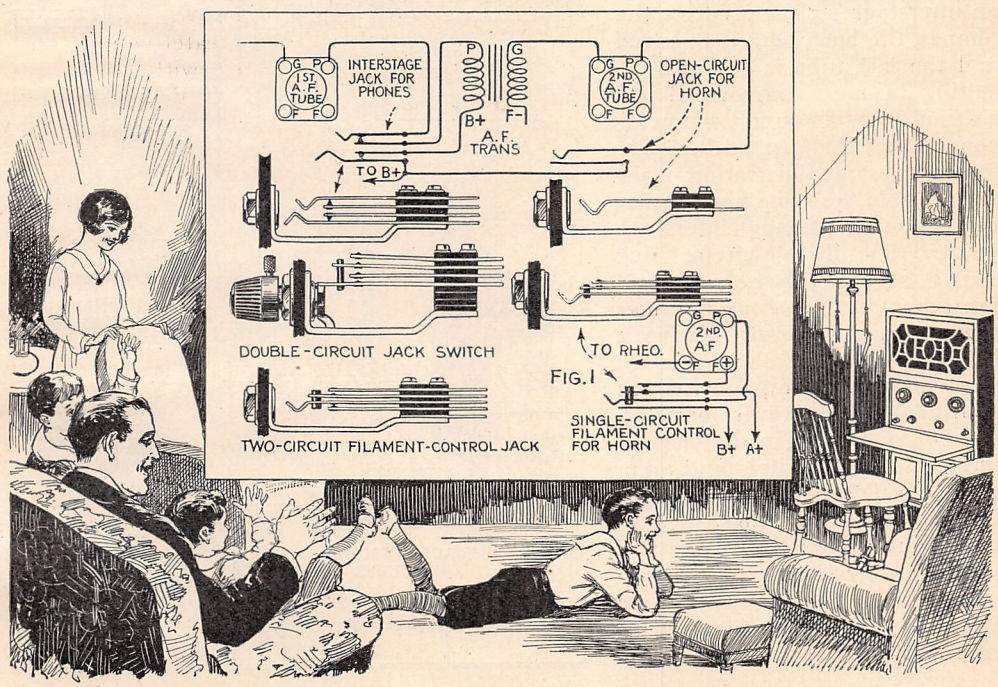
by

Jack Sinclair

JACKS are a small but important part of all radio receivers, every set having one or more of these switching devices. They are made in many types, and differ very little from those of the standard telephone switchboard. The types in common use are shown in Figs. 1 and 2. Those in Fig. 2 are of the new short type, desirable where compact wiring is necessary, as in portable sets, or wherever space is at a premium.

A little knowledge of jacks and their uses is of value to all radio owners and builders as they furnish an easy method of adjusting the set to suit individual needs. For example, one often wishes to use headphones instead of the loud speaker, especially late at night after the other members of the family have retired. If the set employs a horn jack only, it is not practical to detune or choke the set down for the phones. Also, phones are often necessary when locating distant stations which, when once located, may be tuned in at loud-speaker volume.

The insertion of an interstage jack in the first a.f. stage is a simple matter, the wiring diagram and illustration of the type of jack used being given in Fig. 1. If desired, the phone jack may be placed at the out-



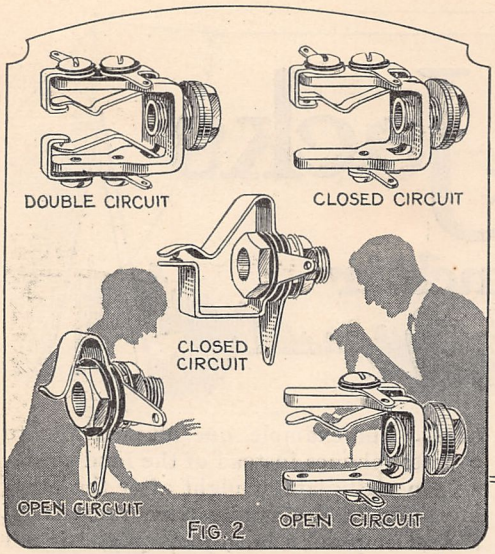


FIG. 2

put of the detector tube, but better DX results are obtained if one stage of a.f. amplification is used.

The diagram at the lower right, Fig. 1, shows a jack of the filament-control type applied to the last or horn stage. When the horn or loud speaker is plugged into this stage, the filament of the tube is automatically lighted. If an interstage jack is used for the phones, the horn plug is removed and the last tube is cut out, resulting in more economical operation. A two-circuit filament-control type is shown at the lower left in the same illustration, making possible the same kind of filament-control at any interstage point. The double-circuit jack switch shown above is an improvement of the standard jack in that no plug is required since it is operated by the small knurled knob at front. This type, which is available in several forms, is handy for cutting in various external devices, switching from phones to loud speaker, or from one speaker to another. Eliminating the plugs, the speaker and phone connections are made permanently in the set, and these jacks are commonly used in receivers of the console type where external leads are to be avoided. A plug combined with an adjustable resistance unit offers a convenient method of controlling the output volume without resorting to detuning or changing the set from its most efficient operating point. This is a simple matter for those using the standard jack and external plug for the loud speaker, but presents a problem where the switch jack is connected in the set itself. Fig. 3 shows the solution of this problem by rewiring the loud-speaker circuit and placing an open-circuit jack near the jack switch, so that the modulator plug can be used to control the volume. The modulator plug is shorted with a small loop of wire, with phone-cord tips at

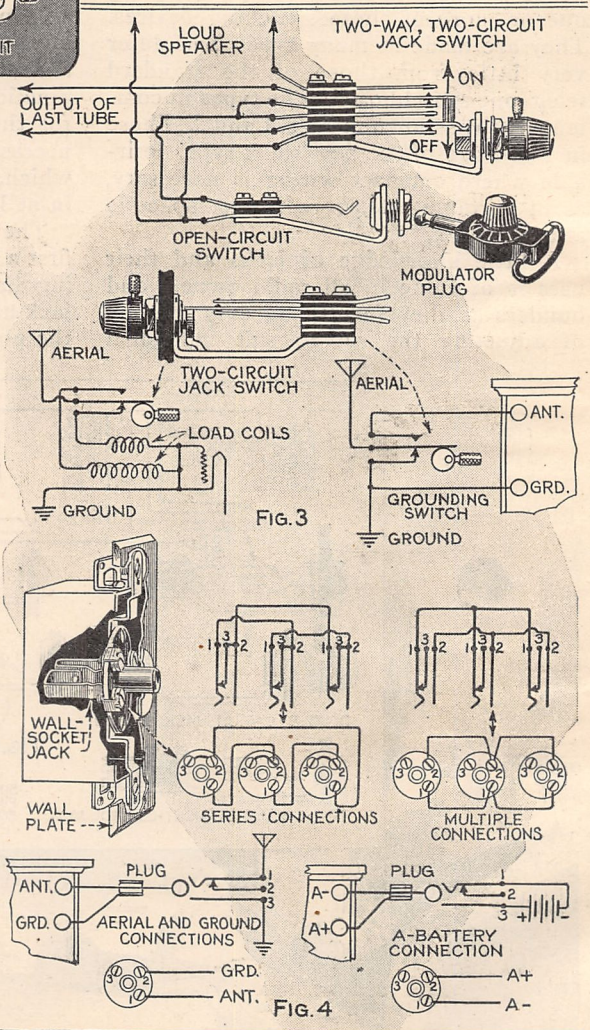


FIG. 3

FIG. 4

either end, to complete the circuit through the plug. When the jack switch is in the on-position and the plug shorted with the wire, the loud-speaker volume is controlled by varying the small knurled knob on the plug. The wire across the plug may be removed and replaced with headphones, connecting the phones and speaker in series if desired. A second loud speaker located in an adjoining room can be plugged in instead of the phones for two-speaker operation if required. When the jack switch is thrown to the off-position the external speaker or phones can be operated independently of the loud speaker in the set. The two-circuit jack switch, Fig. 3, is useful for cutting in load coils as shown in the diagram below, or for an aerial-grounding switch, that may be thrown when the set is not in use, as shown at right.

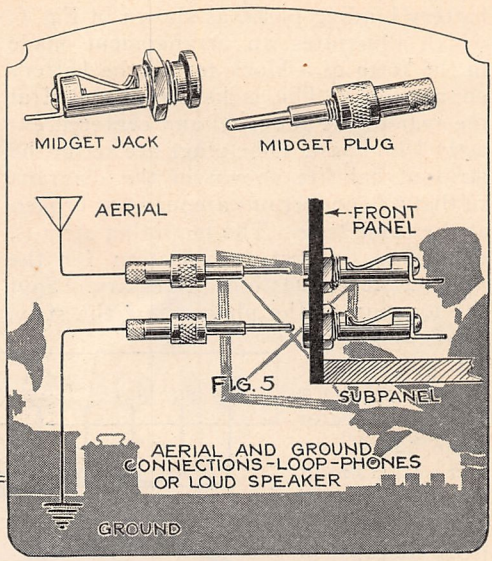


FIG. 5

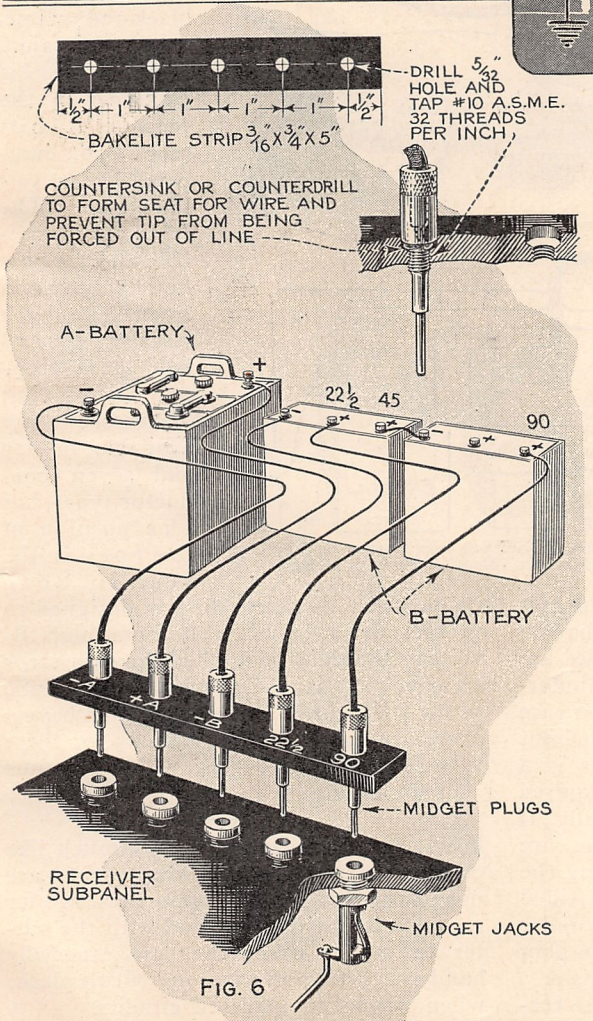


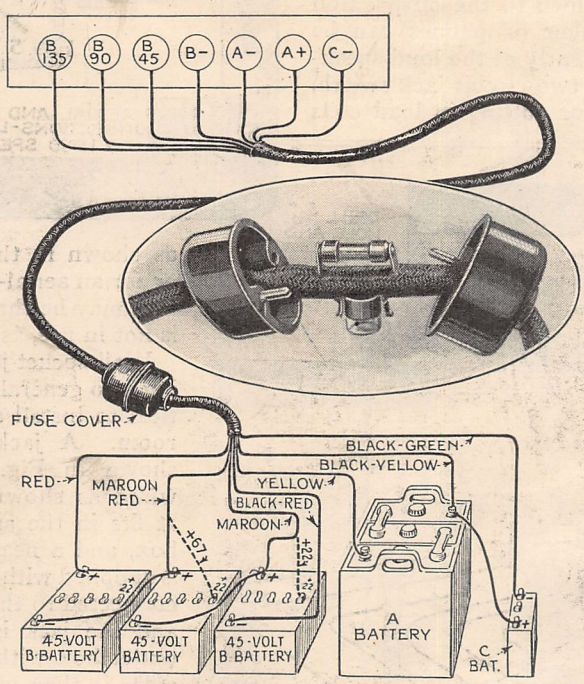
FIG. 6

Wall-socket jacks are now coming into general use and it is practical to install an outlet in every room. A jack of this type is shown in Fig. 4 and is easily wired as shown in the diagram. It fits in the smallest-size outlet box, and a neat brass wall plate is supplied with it. The wires are connected to the screw terminals, and the jack is fastened to the outlet box with two screws; the plate is then attached. In addition to serving as a convenient outlet for connecting phones or loud speakers, this type of jack may also be used for connecting ground and aerial wires to the set, and for battery connections. Batteries may be placed in the basement, or elsewhere, and the wires brought to the wall-socket jack located at a point near the set.

Handy plugs and jacks, known as the midget type and shown in Fig. 5, are in great favor with the experimenter. The aerial and ground diagram shows one of many applications. They are also used extensively for loop connections and to take the place of

battery binding posts, as shown in Fig. 6, which illustrates an arrangement made in the form of a block for all the battery connections. The jacks are mounted at the rear of the subpanel and centered exactly 1 in. apart. The plugs are set in the strip of bakelite shown in the diagram, so that all connections are made or broken at the same time. The mounting strip is, of course, subject to variation for the number of connections necessary. Spot the location of the plugs along the strip, carefully spacing the plugs as indicated. When the connector strip has been laid out, clamp it to the subpanel in the position it is to occupy in the finished set, and using a 5/32-in. drill, perforate the strip and subpanel. The holes in the latter will serve as centers through which the somewhat larger drill required to make the holes for fitting the jacks are drilled. This will insure an accurate line-up of the plugs. The holes are now tapped for the plugs in the connecting strip. For this purpose use a No. 10 A.S.M.E tap having 32 threads per inch. After the holes are tapped, they are countersunk or counterdrilled slightly, to form a seat for the wire and prevent the tips from being forced out of line. The threaded sleeve that is a part of the plug, and which is required when the plugs are used individually, is removed and discarded. Insert the wire in the hollow end of the tip, bringing the bare end out through the hole provided for this purpose, and bend it around under the shoulder above the threads; the plug is then screwed into the bakelite strip.

Flexible, rubber-covered wire is recommended for the battery connections. The jacks are mounted on the subpanel and the set leads soldered to the lugs. The contact springs are held in place by small screws with lock washers under them, to secure a good permanent contact.



Fused Battery Cable with Connections from Battery to Set; Insert, Bakelite Cover Separated, Showing Position of Fuses

Fused Battery Cable Protects Tubes

A new battery cable is provided with fuses designed to protect the tubes, wiring and rheostats in a radio set from short circuits. A small capacity fuse is inserted in the B-negative battery lead, indicated by the black-red wire, and a 2-amp. cartridge fuse is placed in the positive A-battery lead, indicated by the yellow wire. The fuses are removable and are protected from breakage by a bakelite cover held together by two friction pins. These cables are available in five and seven-conductor types, but the position of the fuses is the same in both types. The B-battery fuse is designed to protect the tube filament from high B-voltage should it be applied through error or accident. It will protect a single tube of the 201-A or WD-12 type, which have a current consumption of .25 amp. or three tubes of the UV-199 type, which consume .06 amp. each.

¶Side-cutting pliers look very much like other pliers, although in reality they are not pliers at all, and in radio work are far superior to the regular kind with the cutter below the nose; they are especially handy in cutting off wires in difficult places when wiring complicated circuits.

RADIO